POWER

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The Fireman

By R. T. Strohm

THE daily grind from early morn
Has made his shoulders droop;
His hands are hard and tough as horn
From contact with the scoop.
The flying dust from ash and coal
Besmears his face with jet,
And from his grimy forehead roll
Small rivulets of sweat.

HIS jeans are soiled with oil and dirt;
His shoes are homely clogs;
He labors in his undershirt
And asks no other togs.
His occupation has no charm
For idler or for shirk,
Because it takes a brawny arm
To do that grilling work.

HE plies his scoop through weary days
To feed the blazing maws,
Nor gets a passing word of praise
Or salvo of applause;
Yet were his busy hands to drop,
Each booming, noisy mill
Would turn to silence, and each shop
And factory grow still.

HIS work it is to overhaul
A pump or set a grate,
To build a fallen furnace wall
Or patch a pitted plate.
And if a man possesses such
Experience unique,
His boss may sometimes pay as much
As thirteen bones a week.

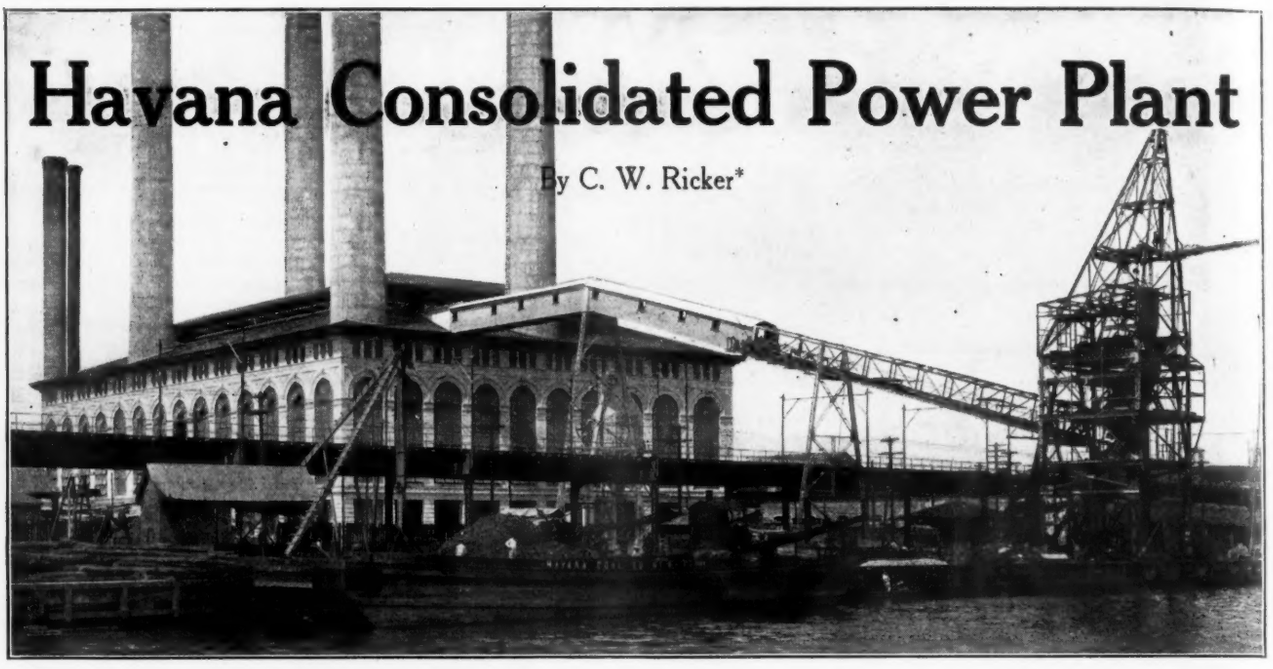
HE scans the pressure gages well,
With keen and watchful eyes,
For in each curving metal shell
A struggling giant lies,
Whose mighty power he controls;
And well he understands
The safety of a hundred souls
Is resting in his hands.

THEN here's a friendly word of cheer—
A pat upon the back—
For him who labors, year by year,
Below the lofty stack.
Behind the grime and dust and tan,
And hidden by the stoop,
There stands a type of real man—
The chap who swings the scoop.

The daily grind
from early morn
Has made his shoulders droop.

Havana Consolidated Power Plant

By C. W. Ricker*



SYNOPSIS—The Havana Consolidated power plant is divided into three sections, each consisting of one 12,500-kv.-a. turbo generator, complete with its condenser, pumps, and eight boilers, containing 6040 sq.ft. of heating surface each. The steam piping of the three sections is connected by a tie-line header, to which the auxiliary group is connected, and which can be supplied with steam from any section or sections of the boiler plant. There are twenty-four 604-hp. water-tube boilers, 16 of which are stoker-fired. Most of the auxiliary units are turbine-driven in order to economize on makeup water. Others exhaust through oil separators. The only known losses of water evaporated in the boiler are through leakage and steam used under the stoker grates. The concluding article will appear in the next issue.

As soon as the consolidation of the Havana Electric Railway Co. and the Havana Gas & Electric Co. was assured, it became evident that a new electric generating station was necessary to take the place of the three old inadequate power stations then in operation; not merely to reduce the cost of producing power, which alone would have fully warranted the investment, but to meet the constantly increasing need for electric energy so that the company could handle the demands made upon it. The plans for the new station were prepared in Havana under the direction of the officers and engineers in charge of operation, and early in 1913 a contract was made for the turbo-generators, condensers, boilers, feed pumps, etc.

The first battery of boilers was put into service Sept. 1, and the complete installation was finished Nov. 1. The first generating unit was started Oct. 1, 1914, and four days later began to carry a load. On Dec. 1, two of the three main units being in regular operation, the Tallapiedra plant, which supplied the larger portion of the lighting and commercial-power load was shut down to be dismantled. On Dec. 11 the third generating unit was put into regular operation and on Dec. 31 all the load on the railway power plant (Colon plant) was transferred to the new station, save that of the direct-current engine generators, which were retained in service until a substation equipment could be installed in the Tallapiedra plant building, which was not ready until February of this year. As soon as new underground feeders were completed the Vedado plant was shut down, and the load of the three original plants is now carried by the new station.

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Plant Site and Building

The tract of land on which the power plant is located has a 600-ft. waterfront on the harbor. A reinforced-concrete wharf with a 30-ft. depth of water, is built across the whole frontage. On this wharf are the double-track freight lines of the Havana Terminal Ry. and on connecting tracks general freight and coal may be received from harbor lighters or seagoing ships and delivered to the storages of the company or to points on the line of the railway.

The completed power-plant building is 278 ft. long, 179 ft. wide and 102 ft. high from the ground floor to the peak of the monitor. The site is known as the Tallapiedra property, and the building is placed in the middle of the tract, leaving a passage 20 ft. wide between the north end of the old plant and room for an 80-ft. extension sufficient for eight additional boilers at the south. A general view of the plant is shown in the frontispiece illustration.

Boiler-Room Equipment

After a comparison of the space required, size of furnaces, accessibility and standardization, 24 boiler units of about 6000 square feet of heating surface each were installed, together with 16 mechanical stokers, each of 115 sq.ft. grate area, which would allow the evaporation of at least 40,000 lb. of steam per hour with the best efficiencies at between 23,000 and 28,000 lb. of steam per hour. Based upon the customary rating of boilers this

is equivalent to a maximum of about 200 per cent. of normal rating, with the best economy between 130 and 150 per cent. As each main turbo-generating unit with its auxiliaries will require about 180,000 lb. of steam per hour at the most economical load, and 225,000 lb. at the maximum continuous load, eight boilers were allotted to each main group, big enough to support the maximum load at best economy and still supply full loads safely with two boiler units out of service for cleaning or repairs. The boilers are set in brick with the front headers 12 ft. above the floor. Sixteen are fitted with improved stokers with flat suspended tile arches projecting in front, with the boiler in a half-dutch oven so that the arches are 6 ft. long, without extending inside the combustion chamber or obstructing the gas passage. The remaining boilers were not equipped with furnaces because they will not be needed immediately.

The boiler equipment, Fig. 3, naturally divides itself into three groups of eight boilers each, corresponding to the main turbines. The boilers are placed on one level and arranged in two rows of 12 each, and in batteries of two facing each other across a wide aisle. The length of the building was determined by the two lines of 12 boilers, with two chimneys in each row, and the width of the boiler room by the depth of the opposing boilers with the necessary aisles at the back and between the two lines. The length so arrived at corresponds with that required for the generating and electrical equipment, leaving room for a fourth main unit to be added when the load reaches the capacity of the original installation.

Space has been left over each line of boilers for the installation of economizers when they become desirable.

Chimneys and Smoke Flues

There are four chimneys, each 268 ft. high above the basement floor and 250 ft. above the grates. They are of reinforced concrete with walls 19 in. thick at the bottom and 6 in. at the top and taper from 20½ ft. external diameter at the bottom to 15 ft. at the top, with separate self-sustaining concrete lining extending 104 ft. above the ground.

The sheet-steel smoke flues, fitted with angles, are 7 ft. wide by 12 ft. high and are placed over the aisles above the boilers. There are six flues, each connected to four boilers by 3x9-ft. vertical branches containing dampers, and to one side of the chimney. The north chimneys now have flues on both sides, the south on one side only; the latter are provided, however, with similar openings for use when the plant is extended, but are now bricked up. These flues are to be covered with heat insulation.

As the smoke flues enter the chimneys over 50 ft. above the ground, the insides of the chimneys were floored over at the boiler-room level and about 18 ft. above, forming two large rooms at the base of each. Doors and ventilating openings are provided, making these rooms suitable for storage of easily injured material, for electrical laboratories or for workrooms.

Coal and Ash Handling

The principal object of the wharf already mentioned is for the receipt of coal, and a complete unloading and conveying system has been installed that can take coal from barges or ships and deliver to the storage bunker of the plant, which holds about 3000 tons, or to railway cars for transportation. Coal can also be received and carried from the storage yard or elsewhere and delivered to the plant bunker. This extra precaution was taken because all coal has to be imported, and it may be necessary to receive and store larger quantities than the plant bunker can hold. The storage yard and trestle have a normal capacity of 6000 tons and in emergencies double that amount.

Above the level of the boilers and over the wide aisle between them is a parabolic reinforced-concrete bunker, Fig. 3, of 3000 tons' capacity and beneath this is a traveling crane with a 10-ton weighing hopper that can receive coal from gates placed every 10 ft. at the bottom of the bunker and after weighing discharge into the 4-ton steel receiving hoppers, set just over the usual feeding hopper of the stokers. By this crane coal can be taken from any desired portion of the bunker and thus prevent bunker fires from becoming serious. The bunker is subdivided by four reinforced-concrete cross-partitions.

Because of the high importation costs, it is more economical to use only the best grade of fuel produced in the eastern part of the United States. At present New River semibituminous coal averaging about 14,800 B.t.u. per lb. mine run is purchased.

Coal-Handling Apparatus

On the wharf opposite the center line of the boiler house is a steel coal-hoisting tower connected by a bridge 270 ft. long, passing over the elevated structure of the Havana Terminal Ry. into the boiler house, 75 ft. above the ground. Coal is taken from the barges by a 1½-ton bucket, hoisted to the top of the tower and dropped into a receiving hopper from which it can pass either into cars placed under the tower or through a crusher onto a belt conveyor, which carries it over the bridge into the boiler house, where it is automatically dropped in any desired part of the bunker. Just before leaving the tower the belt passes over an automatic weighing machine that records the weight of the coal passing on the belt. At the foot of the dock tower is a hopper into which coal may be dumped from cars on the wharf track. A feeder and bucket elevator takes this coal to the top of the tower and drops it through the crusher onto the belt for delivery to the boiler-house bunker. The capacity of the coal-handling equipment is 100 tons per hour, and as the ultimate plant with the 80-ft. south extension will not require over 1000 tons per day, this equipment appears to be ample for all the growth that may properly be provided for at this time.

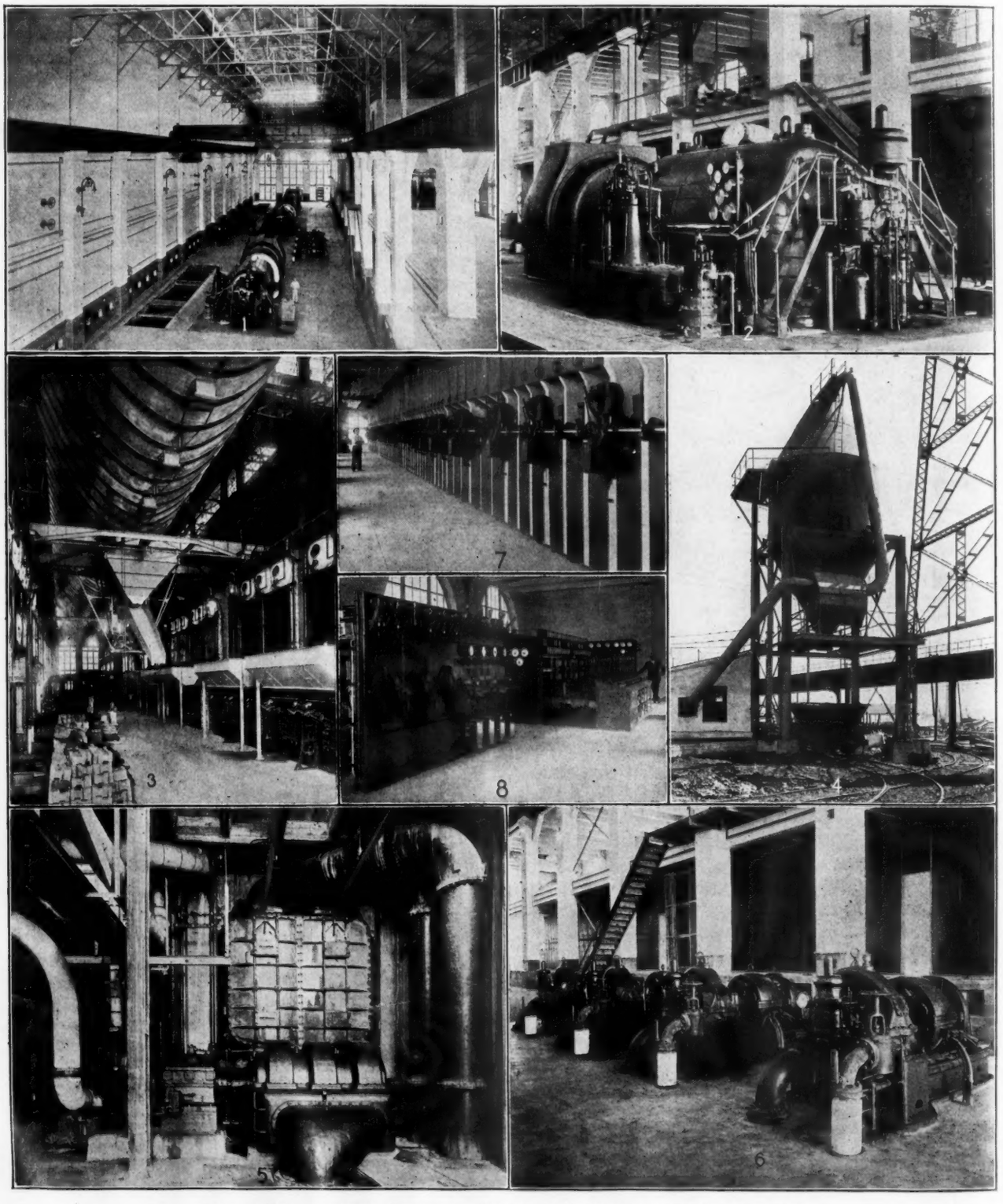
Ash-Handling Apparatus

The boiler-room floor is 18 ft. above the basement, or ground floor, and underneath each stoker is suspended a large concrete-lined steel ash hopper with a dump grate that dumps the ashes into the receiving hopper of the vacuum ash-handling system or into small cars in case the suction system is out of service.

The ash tank and exhauster of the ash system are south of the boiler house under the coal conveyor. The tank, Fig. 4, holding 75 tons of ashes, is connected through a cleaner to a motor-driven exhauster and two 10-in. cast-iron pipes, which lie in concrete-lined trenches, with iron covers, in the basement under the boilers, one pipe under each line of ash hoppers, with plug openings under each hopper.

The ashes travel through the pipe to the elevated tank where they are cooled by a water spray and stored until it is convenient to load them into a railroad car below. The equipment is guaranteed to remove 450 lb. of ashes per minute.

By placing the turbine room along the boiler room with the turbines in a line parallel with the side walls, Fig. 1, the three 12,500-kv.-a. turbo-generators could be located so that they are approximately opposite the corresponding group of eight boilers, four on each side of the center aisle, leaving room at one end for an additional generating unit, as well as about 40 ft. of clear space in the center of the room along one side of which are placed the four 100-kw. exciter units. These are directly driven by steam turbines and each is adequate to excite one main generator at the worst foreseen conditions of load and power factor. They are adapted to operate with voltage regulators, of which two are installed, one connected to each main



FIGS. 1 TO 8. VIEWS OF THE HAVANA CONSOLIDATED POWER PLANT

Fig. 1—Turbine Room. Fig. 2—One of the 12,500 kv.-a Turbines. Fig. 3—Boiler Room. Fig. 4—Ash Tank. Fig. 5—Condenser and Circulating Pump. Fig. 6—Turbine Driven Auxiliaries. Fig. 7—Switching Apparatus. Fig. 8—Switchboard

bus. The exciters, Fig. 6, are on the turbine-room floor in front of, and in plain view from, the operating room.

The main generators, a near view of one being shown in Fig. 2, are wound for 2300 volts, three-phase, 60-cycle at 1800 r.p.m. and are Y-connected with the neutral lead brought out. The normal capacity of each is 12,500 kv.-a. with a temperature rise of 45 deg. C. With a continuous load of 15,600 kv.-a. the rise is 50 deg., and the generators are guaranteed to safely carry an overload of 50 per cent. above normal for one hour with a maximum temperature of 60 deg. above atmosphere. They are self-

PRINCIPAL EQUIPMENT OF THE HAVANA ELECTRIC RAILWAY, LIGHT & POWER CO'S NEW PLANT

No.	Equipment	Kind	Size	Use	Operating Conditions	Maker
3	Turbo-generators	Horizontal, double-flow	12,500-kv.a.	Main units	1800 r.p.m., 200 lb. steam, 150 deg. superheat, 2350 volts, 3-phase, 60-cycle	Westinghouse Companies
4	Turbo-generators	Horizontal, single-wheel	100-kw.	Exciters for main generator	2400 r.p.m., 200 lb. steam, 125 volts, d.-c.	Westinghouse Companies
24	Boilers	Water-tube	604-hp.	Steam generators	200 lb. pressure, 150 deg. superheat	Babcock & Wilcox Co.
24	Superheaters	Foster	604-hp.	Superheating steam	150 deg. F.	Power Specialty Co.
16	Stokers	Westinghouse, new model	115 sq.ft.	Boiler furnace	Engine-driven, natural draft	Westinghouse Machine Co.
4	Chimneys	Tapered concrete	14x275 ft.	To serve boilers	Natural draft	Weber Chimney Co.
2	Heaters	Open, feed-water	300,000 lb. per hr.	Heating boiler-feed water	0 to 2 lb. pressure	Hoppes Manufacturing Co.
2	Meters	Water, V-notch	400,000 lb. per hr.	Measuring condensate and boiler feed	0 to 2 lb. pressure	Hoppes Manufacturing Co.
1	Crane	Traveling	50 ton main, 10-ton aux.	Turbine-room service	Electrically operated	Toledo Bridge & Crane Co.
4	Motors	Induction	Two- 37- one-22- and one 11-hp.	With crane	Three-phase, 230 volts	General Electric Co
3	Condensers	Surface	30,000 sq.ft., cooling surface	With main turbines	200,000 lb. steam, 85 deg. water, 27½ in. vac.	
					150,000 lb. steam, 28 in. vac.	Westinghouse Machine Co.
3	Pumps	Triple impeller centrifugal	42-in. 37,000 gal. per min.	Condenser cooling water	275 r.p.m., turbine driven	Westinghouse Machine Co.
3	Turbines	Horizontal single-wheel		Driving circulating pumps	1375 r.p.m., 200 lb. steam	Westinghouse Machine Co.
3	Pumping sets	Air pumps and centrifugal	For 30,000 sq. ft. condenser	Air and hotwell pumps	2500 r.p.m., turbine-driven	Westinghouse Machine Co.
4	Pumps	Three-stage centrifugal	5-in., 400-gal. per min.	Boiler-feed water	3000 r.p.m., 250 lb. water pressure	Westinghouse Machine Co.
3	Pumps	Simplex	8x10x16-in.	Station-service water	200 lb. steam, 150 deg. superheat	Union Steam Pump Co.
3	Pumps	Centrifugal, single-stage	1¼-in. 30 gal. per min.	Pumping condensate to turbine glands	Motor-driven	Henry R. Worthington
3	Motors	Induction	3-hp.	Driving condensate pumps	220 volts, 3-phase, 60-cycles	General Electric Co.
1	Bunker	Coal, Ferro Inclave	3000 tons	Coal storage	Filled by conveyor system	Guarantee Construction Co.
1	Conveyor	Belt	24 in. wide, 350 ft. long	Coal to bunkers, 100 tons per hr.	Motor-driven	Link-Belt Co.
2	Motors	Induction	25-hp.	Driving conveyor	230 volts, 3-phase	General Electric Co.
1	Coal hoist and tower	Steam-operated	101 ft. high	Takes coal from vessels	Steam-operated	Mead-Morrison Mfg. Co.
1	Scale	Automatic belt	100 tons per hr.	Weighing coal to bunkers	Conveyor belt passes through weightometer	Merrick Scale Manufacturing Co.
1	Elevator	Chain-bucket	100 tons per hr.	Takes coal from cars or wagons	Motor-operated, 15-hp.	Link-Belt Co.
1	Conveyor system	Ash, vacuum	10-in. pipe	Ash removal	Motor-driven, 75-hp.	
1	Crane	Traveling weighing	10 tons	Distributes coal from bunkers to stokers	Driven by 20-hp. motor	Buffalo Scale Co.
1	Crusher	Coal, single-roll	100 tons	Crushing coal	Driven by 20-hp. motor	Mead-Morrison Mfg. Co.
24	Valves	Nonreturn, stop	8-in.	On boiler outlets	205 lb. steam, 150 deg. superheat	Foster Engineering Co.
96	High-pressure valves, 2 to 14 in. size					Chapman Valve Mfg. Co.
371	High-pressure valves, ½ to 2 in. size					Hancock Inspirator Co.
6	Relief valves, semi-balanced and other miscellaneous valves					Atwood & Morrill
25	Exhaust line valves, 11-gate, 14-check, 9 to 20 in., 6 to 12 in., respectively					Chapman Valve Mfg. Co.
28	Exhaust drain, and blowoff line cutoff valves					Chapman Valve Mfg. Co.
72	Blowoff valves, 2½ in. size					Babcock & Wilcox Co.
72	Blowoff cocks, asbestos-packed, 2½ in. size and other miscellaneous valves					Pratt & Cady Co.
27	Water and air valves					Chapman Valve Mfg. Co.
70	Boiler-feed system gate valves, 2½ to 8 in. Other miscellaneous valves					Chapman Valve Mfg. Co.
9	Primer valves					The Wm. Powell Co.
3	Primer valves					Jenkins Bros.
3	Exhausters, 4 in.					Schulte & Koehring Co.
72	Air cocks on compressed-air and vacuum cleaning system and other miscellaneous cocks and valves					Kelly & Jones
12	Steam traps for high-pressure drains					Strong, Carlisle & Hammond Co.
62	Thermometers for various purposes also 5 recording thermometers					Taylor Instrument Co.
1	Recording thermometer on boiler blowoff lines, 2 recording pressure gages					Industrial Instrument Co.
34	Pressure and vacuum gages					Schaeffer & Badenberg Manufacturing Co.
	Pipe covering, 85 per cent. magnesia					Keasby & Mattison
	Transformers, oil circuit breakers and miscellaneous apparatus					Westinghouse Elec. & Mfg. Co.
1	Storage-battery system, 110-volt, d.-c.					Electric Storage Battery Co.
	Feeder cables					John A. Roebling Sons Co.
	Feeder cables					Standard Underground Cable Co.
1	Three-phase line, base wire					U. S. Steel Products Co.
1	Three-phase line, base wire					Standard Underground Cable Co.
	All high-pressure and exhaust steam, boiler feed-water condensate and oil piping					Benjamin F. Shaw Co.

ventilated by fans from the rotor, air being taken from below to the bedplate and discharged upward through the top of the casing. No external air-circulation apparatus or air cooling device is now contemplated, although, if necessary, it is probable that considerable additional capacity could be obtained in that way.

The water for sealing the glands of the turbine is taken from the condensate header by small motor-driven centrifugal pumps, one for each main turbine, and it is pumped into corresponding tanks about 20 ft. above the turbine-room floor, with a connection to the turbine glands, thus maintaining the necessary 10 lb. pressure. An excess of water is pumped, which overflows through a sight connection in the turbine room in full view of the operator, back into the condensate header. If the gland pump fails to deliver water, a float valve in the tank admits water from the plant service system and there is a hand-operated valve near each turbine to admit service water directly to the glands. The continuous use of city water causes no harm during the short time needed to remedy a defect in the distilled-water supply.

Each main turbine has a separate free exhaust pipe that extends under the floor into the boiler room, rising between the middle wall and the smoke flue to above the roof. The atmospheric relief valves are in the horizontal

run close to the condenser and are hydraulically operated.

While each of the turbines has an independent oiling system with its own oil pump and cooler, two ½-in. oil lines are run the length of the turbine room beneath the floor, with openings that may be connected to the turbines. These lines are connected in the center of the basement to the storage tanks and filter, so that used oil can be drawn from the turbines and replaced by new or cleaned oil. To avoid a chance of loss of oil by unobserved leaky valves the tank lines are disconnected when not in use.

A 50-ton traveling crane with a 10-ton auxiliary hoist runs the length of the turbine room about 35 ft. above the floor. A brick wall extending from the boiler-room roof to the floor divides the boiler house from the turbine room, but the basement is open and continues to the further side of the main-unit foundations. The main generating units are set on steel beams, supported on concrete piers, leaving space under the units and between the pier open for auxiliary apparatus and ventilation.

Between the turbines and the exciters and the central wall, large openings are left in the turbine-room floor, so that all the auxiliaries in the basement are in plain view from above and all except the condenser circulating pumps and the heaters can be reached by the main crane.

Applications of Congealed Brine

By R. L. Shipman

SYNOPSIS—The writer points out that there are certain advantages in freezing the brine during periods of light demand, thus storing cold which may be used when the demand on the plant increases. Plants designed with this end in view seem to require less pipe—coil surface—than is usual.

Where the demand upon a refrigerating plant is severely irregular, as in making ice cream, cooling fresh or condensed milk and cream, and even under certain conditions in ice-making, important advantages can be gained by freezing a portion of the brine charge during periods of light demand.

It requires the extraction of some 8500 heat units to freeze a cubic foot of brine, but only about 1200 to cool a cubic foot of brine through a temperature of 20 deg. In other words, seven times as much cooling effect can be stored at almost any desired temperature by freezing brine as by submitting it to change in temperature of 20 deg.

With a fluctuating load and heavy brine that will not freeze, it is usually necessary to hold the brine at a comparatively low temperature to insure a safe margin in cooling capacity. But this low temperature means low back-pressure, which in turn means expensive refrigeration with large radiation losses, while with light brine, freezing at a comparatively high temperature, the back-pressure runs proportionately high, affording less expensive refrigeration. But the congealing principle, of course, can be used only with single pipe coils.

It seems to be a general impression that to allow ice to appear on the coils in a brine tank is to materially reduce their capacity for collecting heat, and while the writer has not made systematic and accurate quantitative experiments on the condition, he has had several important experiences that lead him to quite a different conclusion, which can probably be sustained by well-known principles bearing upon the subject. For example, the heat-collecting capacity of coil surface submerged in a brine tank ranges from 5 to 25 heat units an hour per square foot of surface per degree difference in temperature, depending upon the rate of circulation of the brine in the tank; while with freezing, for a moderate thickness of ice, a square foot of pipe surface may collect heat at the rate of several hundred heat units an hour per degree difference in temperature.

Some time ago the writer designed refrigerating systems for two milk-condensing plants, one of 20 and the other of 30 tons' refrigerating capacity. In the former about 700 ft. of 1¼-in. pipe was placed in a brine tank, and some manufacturers who bid on the work called attention to the condition that the 700 ft. of pipe, which was only about 35 ft. per ton of machine capacity, was not enough for the size of machine proposed. But when the system was put into commission the specific gravity of the brine was adjusted so that it would begin to freeze at about fifteen degrees above zero, F., and the piping was found to be ample for the machine, as at normal speeds the machine could run all day without reducing the suction pressure much below 15 lb.

In the 30-ton plant, about forty feet of 1¼-in. pipe was allowed per ton of machine capacity. The writer happened into the plant some time after it was put into commission and found that the operators had made the brine too strong to freeze at ordinary temperatures and the suction pressure was running below 5 lb., showing that the 40 ft. of pipe was insufficient for that method of operation, as should be expected, as practice has shown that it is necessary to use from 150 to 200 ft. of this pipe in submerged coils per ton of machine capacity when the brine is not allowed to freeze.

A series of circumstances with an ice-making system led to an important observation bearing upon this subject. During the spring and fall seasons the plant was shut down intermittently on account of the short demand, no storage being used and the demand being drawn direct from the freezing tank. The machine was of 50 tons' refrigerating capacity, and when the demand was only a few tons of ice a day, a few hours' run of the compressor at a fair speed would bring the brine from a temperature around 30 deg. down to 10 deg. and start the ice cracking in the cans, making it necessary to run slow or stop the machine. But with the compressor shut down, the rise in temperature of the brine was nearly as rapid as was its drop with the machine running, on account of its comparatively small heat capacity from merely changing its temperature, making it necessary to run the machine quite frequently.

Later, the brine became weak so that it would begin to freeze at from 12 to 15 deg. This was found to be a

desirable condition during these seasons of short demand, because the freezing of the brine would hold the load up so that the compressor could be run for a whole day at a good speed and high back-pressure, and then be shut down for much longer periods than formerly without injury to the ice in the cans.

It requires a thickness of only a little more than 1 in. of ice on 1¼-in. pipe to be equal to a cooling effect of 1000 heat units per foot of pipe, while a thickness of 2 in. would be equal to about 3000 heat units of cooling effect per foot, which shows the large cooling capacity of the cooling surface with the congealing system if the thickness of ice is not run excessive. With the use of the congealing tank it is important to direct the flow or circulation of the brine so that the ice will thaw as evenly as possible, to prevent the pipes from freezing together in portions of the tank and being put out of effective action.

A special advantage of the congealing tank in cooling rooms where it is desired to run the machine intermittently with room temperatures above 32 deg. is that the surface of the tank will remain below the freezing temperature and prevent the melting of the frost it contains and thereby prevent excessive moisture in the air of the room. This reduces to a minimum or entirely prevents the sweating of the walls and ceiling of the rooms. It is frequently possible and convenient to provide gravity brine circulation to several rooms from one congealing tank.

Vulcan Vertical Water-Tube Boiler Cleaner

A new departure in soot blowers for the Wickes type of vertical water-tube boilers has recently been installed in the plant of the Schwartz Brewing Co., Buffalo, N. Y. The apparatus is manufactured by the Vulcan Soot Cleaner Co., of Du Bois, Penn.

The cleaner is shown in the accompanying illustrations. The apparatus is a permanent installation and is operated without opening doors or interfering with the boiler operation. When the apparatus is installed the original cleaning doors may be preferably sealed to prevent infiltration of cold air.

The cleaner consists of four elements, three of which are of one type, which are indicated on the sectional side elevation as *A*, *B* and *C* (Fig. 1). The fourth element is of a different type and is designated as *D*.

The blower elements *A*, *B* and *C* are constructed to overcome the special difficulties met in this type of boiler. The distance between adjacent rows of tubes is so small that a blower element of large diameter cannot be inserted. Using one of small diameter, and consequent small capacity, it is impossible to supply enough steam to enable the nozzles to be positioned so as to direct steam between each pair or row of tubes. This difficulty is met by making the blower element adjustable longitudinally and telescopic at the inlet end within a steam head or cylinder permanently located outside the boiler setting, and by positioning the nozzles on the element so that a nozzle comes on the space between every other row of tubes. This cuts in half the number of nozzles necessary to clean the boiler; or, in other words, it practically doubles the capacity of the small-diameter blower element.

This will be understood by referring to the illustrations; for if the blower element is rotated when extended to the set limit within the boiler (see element *A*, Fig. 2), one section of the tubes will be cleaned, and then, if the inlet end is telescoped within the steam head cylinder *E* a predetermined distance, which is equal to one tube spacing (see element *B*), and the element again rotated, another section of the tube surface will be cleaned and all the deposit blown from the heating surface.

Blower element *D* in most cases is not made adjustable longitudinally, for, being installed above the baffle where there is ample space between the tubes, it has sufficient capacity to supply steam to the necessary number of nozzles. This element is fitted up with two-way nozzles to blow in opposite directions, so disposed as to project steam in the space between each pair of tubes; and as this element rotates through 180 deg., all tube surface on each side of the baffle is covered.

To operate the cleaner takes but a few minutes. First, the supply valve is opened and the supply line drained. The main valve on the header is then opened and the

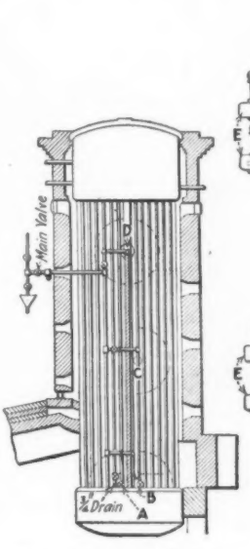


FIG. 1. SECTION OF BOILER AND BLOWERS

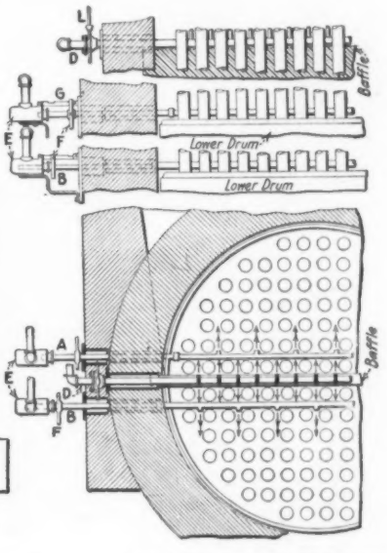


FIG. 2. DETAILS OF ELEMENTS APPLIED TO A BOILER

header drained, after which the blower elements are operated. Blower element *A* is first operated. The control valve to this element is opened and by means of an operating handle the element is rotated within set limits (shown by the arc of the circle, Fig. 1). This cleans one section of the tubes, and in order to clean the other section of the tubes covered by this element it is telescoped from the steam head *E* so that the nozzles move over one tube space, when the operating handle *F* will be in engagement with the notch in the notched bar *G*. The element is then rotated as before and the steam shut off.

Next, the element *D* is operated by rotating it slowly through an arc of 180 deg., which cleans all tubes on each side of the baffle. Elements *C* and *B* are operated exactly as element *A*—the supply and main valves are closed, the drain valves are opened and the operation is completed.

The apparatus is so simple that there is nothing to get out of order. The operation is positive and the operator cannot make a mistake. Furthermore, the result is thorough, and a boiler may be kept at its maximum efficiency with regard to heat absorption.

FIG. 5. MACHINERY PALACE AND ITS STATUARY DECORATIONS

Panama-Pacific Exposition--II

By F. R. Low

SYNOPSIS—A Martian returning from a visit to the Centennial Exposition could have carried to his people a fair idea of what we knew about power generation and transmission. The shortcomings of the exposition at San Francisco in this respect. Descriptions of notable exhibits in the power-line.

Power Plant Apparatus

If some two thousand years from now the civilization of the nineteenth century should become buried in an obscurity as deep as that of the Aztecs or Babylonians, the archæological delver who should discover a report of the commission to the Centennial Exposition of 1876 would be able to construct from it for his contemporaries a comprehensive and lucid picture of the industrial life of that period. The state of the arts, especially of the industrial and mechanical arts, was there depicted in satisfying completeness. The young power-plant engineer of today can find in the comprehensive reports of those commissioners and judges the best possible datum upon which to base his estimate of the progress of the past twoscore years.

The Columbian Exposition at Chicago in 1893, the Paris Exposition in 1900, the Louisiana Purchase Exposition at St. Louis in 1904, were all fairly representative of the then existing state of the art. An inhabitant of Mars, alighting in either exposition and returning without having been outside of its gates, would have been able to convey to his fellow Martians a good idea of how we produced and transmitted power and of the most approved apparatus and appliances which we employed.

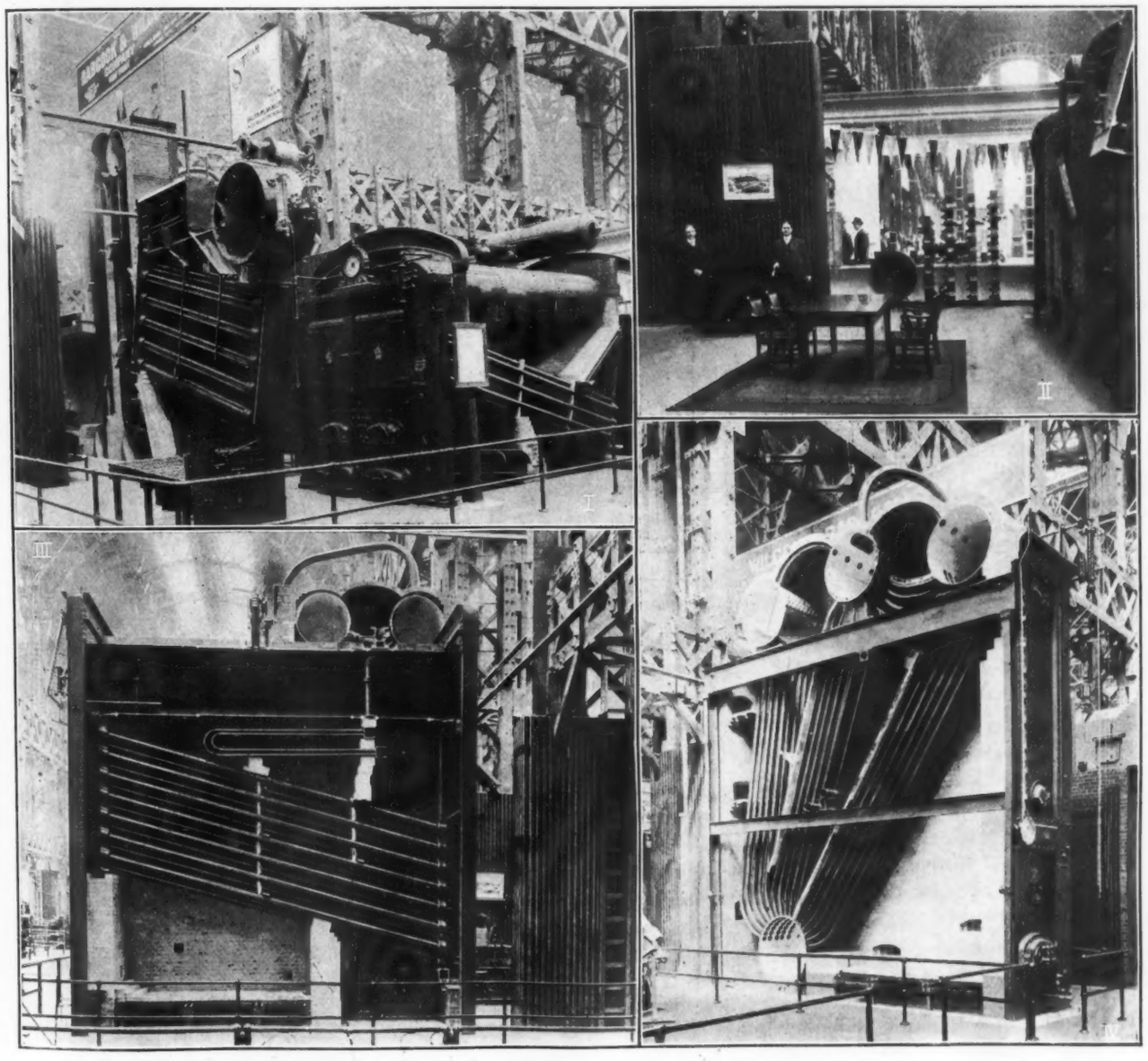


FIG. 6. THE EXHIBIT OF THE BABCOCK & WILCOX COMPANY

The Panama-Pacific Exposition at San Francisco is pitifully lacking in this respect. Commemorative of an achievement of engineers rather than of warriors and statesmen, of an event in the development of the world rather than of a nation, this exposition fails signally as an exponent of the state of the engineering arts, and what engineering exhibits it has assembled are largely local to America.

The international exposition as an arena for an industrial contest, where designers and producers placed the products of their best skill and effort in serious competition for the judgment of the world, where engines and boilers and other apparatus were put to competitive test and won or lost on their performance, is as out of date as the spelling match. The only try-outs at this exposition—and it has been true of all the later ones—are on the race track and in the livestock department. Nobody need fear to stay out now because he will be thought not to dare.

The glory of the old exposition, even to the ordinary visitor, was the power plant, the mammoth engines, the visible source of the light and movement of the great assemblage. Grant that the ancient glory of the reciprocating steam engine as the preëminent source of industrial power has departed, grant that the trend toward aggregation has displaced thousands of these smaller units by a comparatively small number of powerful turbines—the steam engine has not reached a state of decadence that is indicated by the presence of one 150-hp. high-speed four-valve unit as its sole operative representative, and this still waiting for steam when the Exposition is half over and with no load but a water rheostat to run if it ever does get steam. The only other American reciprocating steam engine on exhibition is a small but sturdy two-cylinder unit shown, not piped up, among the other machinery of an iron-works exhibit. The extraplanetary visitor would carry to his fellows no idea that we had any knowledge of compounding or of the uniflow principle; there is no Corliss valve, no releasing valve gear of any sort, no poppet valve, no locomobile, nothing representative of later-day practice except this example of the adaption, by a one-time builder of large steam engines, of his product to the narrowing field, and this exhibited as an attraction secondary to the oil engine, which is engaging his principal interest.

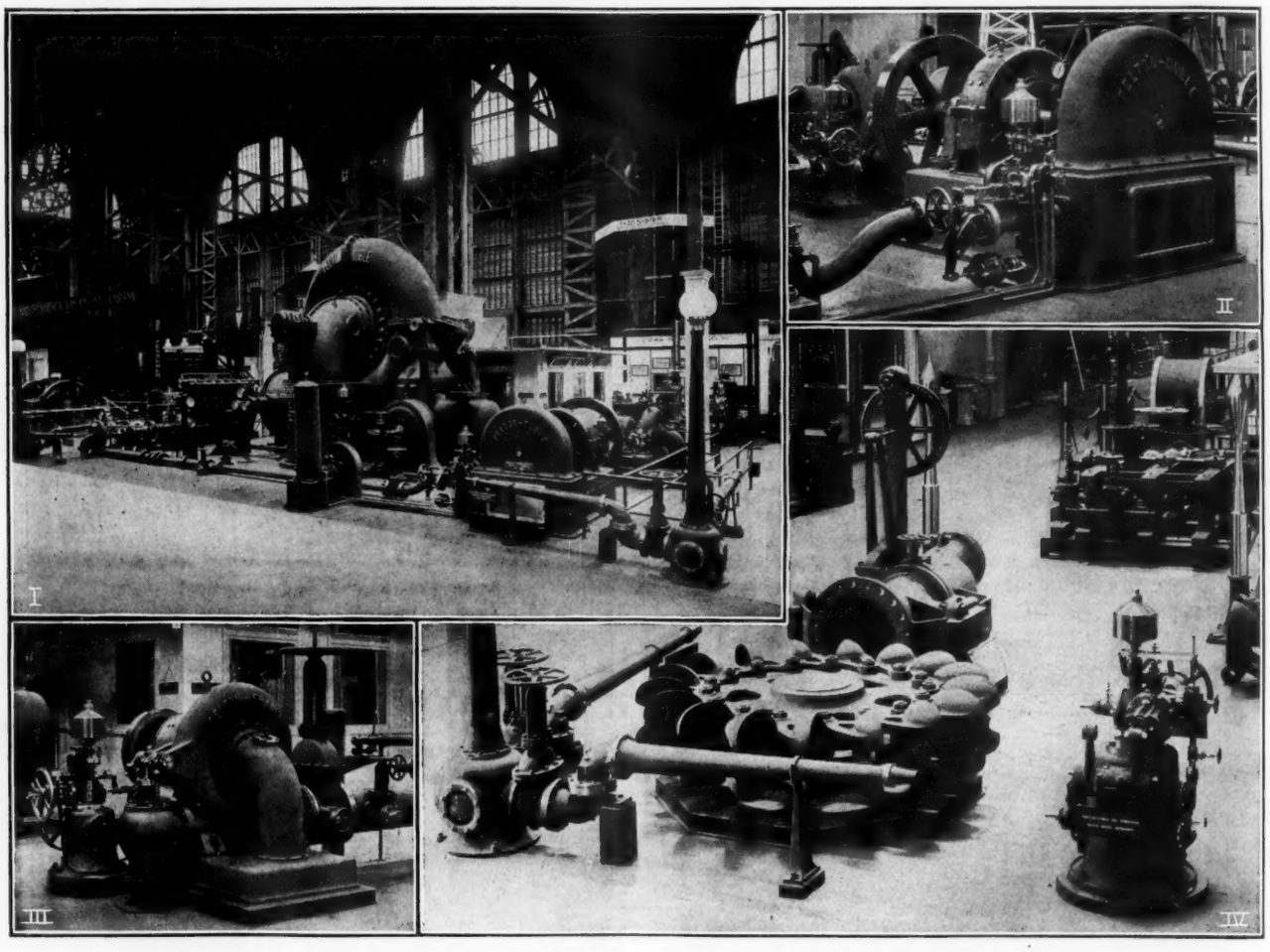


FIG. 7. EXHIBIT OF THE PELTON WATER-WHEEL COMPANY

The only steam boiler designed as an operating exhibit is a Badenhausen unit of 250 hp., which was expected to furnish steam for the one engine prepared to use it and for a number of other scattered users for other than power purposes. But this is hanging in its supports, not bricked in, and with never a workman nor a representative in sight. This statement should be modified by the admission that the low-pressure, hot-water boilers used for maintaining a tropical temperature in the Horticultural Palace are operated as a working exhibit. The only other complete boilers are a little Seabury, for yacht and similar purposes in Machinery Building and a Belleville in the French section of the Manufactures Palace. The

boiler situation is saved, however, by the really excellent exhibit of the Babcock and Wilcox Co., where there are shown full-sized sections, in actual metal and firebrick, of the various types of boilers which they manufacture, as well as sections of different types of headers and drum heads showing the method of tube and handhole-plate insertions, assemblage, etc., Fig. 6. The exhibit in this form, showing the methods of support, of baffling, of furnace construction, the location and construction of the superheater, etc., is more illuminating and better in every way, except for competitive test, than a working exhibit would be. A manifestation of localism, even in the exhibit of a company doing a world-wide business in an exposition designed to be international, is the stress put upon oil burners and the absence of any mechanical firing apparatus, although a chain-grate stoker is one of their products. Their exhibit comprises also the boiler which they entered at the Centennial Exposition nearly forty years ago and which took part in the famous Centennial tests made by Charles E. Emery, Charles T. Porter and Joseph Balknap (panel I, Fig. 6). This boiler was originally built for the Centennial Exposition, where it took the first prize, and was sold soon after the exposition closed to the De Castro & Donner sugar refinery of Brooklyn. This refinery was later acquired by the American Sugar Refining Co. and the boiler was kept in active service up to about four years ago, when it was reacquired by its builders in part exchange for larger units.

FIG. 8. CHIEF G. W. DANFORTH OF THE DEPARTMENT OF MACHINERY EXHIBITS AND MEMBERS OF INTERNATIONAL JURY OF AWARDS FOR THAT DEPARTMENT

Upper row, left to right—Captain Bryan, U. S. N., Inspector of Navy Yards; Fred R. Low, Editor of "Power"; John Hunter, Chief Engineer, United Electric Light & Power Co., St. Louis, Mo.; Captain McAllister, U. S. Coast Guard; F. J. Frank, "Iron Age"; D. S. Watkins, Sacramento, Calif.; W. H. Crosby, Buffalo, N. Y.; Cecil P. Poole, Mechanical Engineer for the City of Atlanta, Ga.; Dr. Carl Hering, Consulting Electrical Engineer, Philadelphia, Penn.; H. W. Bringhurst, Seattle, Wash.; Thomas Norris, San Francisco, Calif.; Prof. W. K. Kavanaugh, University of Minnesota; Jesse M. Smith, Consulting Engineer, New York City; N. A. Bowers, McGraw Publishing Co., San Francisco, Calif. Lower row—Prof. H. W. Hibbard, University of Missouri; Prof. C. E. Lucke, Columbia University; Prof. John T. Faig, University of Cincinnati; J. C. Mengel, Pennsylvania R. R., Altoona, Penn.; G. W. Dickie, builder of the "Oregon," San Francisco, Calif.; Lieut. G. W. Danforth, Chief of the Department of Machinery Exhibits Panama-Pacific Exposition; W. H. Onken, Jr., Associate Editor, "Electric World"; Prof. C. N. Jansky, University of Wisconsin; G. N. Brill, Consulting Engineer, Berkeley, Calif.; Emil Fisher, for China Commission; Calvin W. Rice, Secretary, American Society of Mechanical Engineers.

Nor has the victorious steam turbine a display at all commensurate with the importance that it has attained as a prime mover, a single 625-kv.-a. combination velocity-stage and Parsons unit, open for inspection in the Westinghouse exhibit, being the only American example. While as an exhibit this is more satisfying to one who wants to see why it goes and how it is designed and made than a running machine would be, one cannot help wishing that there were a more comprehensive display and something, were it only photographs, to show the Martian that one thousand horsepower is not the limit of our attainment in this direction. If he looked sharply he would find a small single-runner reëntry type as the operating end of a La Blanc condenser in the same exhibit.

Speaking of condensers, there is perhaps no apparatus connected with power-plant engineering, with the exception of the turbine itself, in the development of which so much progress has been made since the last great exposition as in that of the condenser, and particularly of the surface condenser. The demonstrated ability of the steam turbine to use to advantage high degrees of vacuum, the consequent effort for high air-pump efficiency concentration of condensing activity without undue restriction of flow passage have vastly modified our ideas as to heat transmission and condenser design. Of all of this the listening ear of the Martian would catch no whisper. The condenser shown is a jet of about ten-thousand pounds per hour capacity, and its La Blanc air pump is the only exemplification of radical departure in condenser design in the Exposition.

In the internal-combustion engine field the showing is much more representative. The crowning glory of Machinery Hall in the prime-mover line is two vertical four-cylinder Diesel engines of 500 hp. each—one by the Busch-Sulzer Co. and the other by the McIntosh & Seymour Corporation, both in operation. Smaller units are shown by the New London Ship & Engine Co., and the Fulton Manufacturing Co., of Erie. As there are less than a dozen builders of this type of engine in the country and most of these are just getting fairly started, this is a very creditable showing, especially as all are built "in the East," as they say here even for the Mississippi Valley, and most of the exhibits required transportation of this heavy machinery practically across the continent. In heavy-oil injection engines of the semi-Diesel class there are three examples; of the carburetor type, a great many. We shall devote a special article to the description of the engines.

Our Martian visitor would receive no intimation that we knew about such a thing as the gas producer, and the only truly gas engines are small units running on city gas. Of the troubled history and present status of the large gas engine in America there is no indication.

But when it comes to water power the visitor to the Panama-Pacific Exposition will find an exemplification of our most advanced practice in impressive sizes and with the most admirable arrangements and facilities for demon-

stration. True, there is but one exhibit, the Pelton-Doble, Fig. 7. The dominating feature as will be seen from panel I is a 20,000-hp. Francis turbine designed to operate at a speed of 360 r.p.m. under a head of 500 ft. After the Exposition this will be used upon the Lake Spaulding development of the Pacific Gas & Electric Co. This is the most powerful horizontal, single-runner, single-discharge Francis turbine yet built. The phosphor-bronze runner, 74 in. in diameter, is exhibited separately. There are also shown in panel IV the parts of a 20,000-hp. impulse wheel for this company's Drum Power Plant. The runners, of which there are two, 107 in. in diameter carrying 16 buckets each, weigh 12,000 lb. apiece, and each develops 10,000 hp. at 360 r.p.m. under a 1350-ft. head. There is used upon each wheel only one jet, supplied by a needle-regulated deflecting nozzle suspended in trunnions and moving over a ball joint, the axis of which coincides with that of the trunnion through which it receives the water. This nozzle is deflected by the governor so that more or less of the water escapes the bucket for sudden changes of load, while the central needle is operated by hand or by an electric motor, enabling the operator to adapt the area of the nozzle so closely to the maximum demand as to secure a high degree of water economy. The forward end of this deflecting nozzle floats upon a hydraulic plunger connected to the main pressure pipe and balancing the weight of the main nozzle body and the water contained in it.

To demonstrate the operation of these two types (reaction and impulse) there are two wheels—a 100-hp. impulse operating under a head of 300 ft. (panel II) and a 50-hp. reaction, or Francis, operating under a head of 50 ft. (panel III). The water for the latter is supplied by a deep-well pump of the turbine type run by a 100-hp. Westinghouse three-phase induction motor and delivering 4500 gal. per min. The water for operating the Pelton wheel is furnished by a centrifugal pump operated by a 180-hp. Nelseco-Diesel engine, to be described elsewhere, at 1800 r.p.m. through a Falk gear, furnishing 1100 gal. per min. at a pressure equivalent to a head of 300 ft. The Francis turbine has a specific speed of only 84 ft. Both of these operative turbines are provided with venturi meters for measuring the amount of water supplied, pressure gages, wattmeters for measuring the output of the generators to which they are connected, tachometers and all the paraphernalia for making an efficiency test. The Pelton wheel is arranged with a glass cover plate and mirror, so that the action of the jet upon the wheel may be observed from the aisle, and it is equipped with the highest type of oil-pressure-control hydraulic governor with a secondary or waste nozzle to which the surplus water is at first deflected with the diminution of the load and which gradually closes, avoiding water ram. The action of this governor is beautifully demonstrated, both in the working machines and in a pair of separately mounted jets which may be operated by hand. There is also a laboratory impulse wheel made of bronze, with glass side plates allowing the action of the water to be seen, a full line of small motors, an impulse wheel mounted upon a wooden frame and equipped with a simple jet deflector used when the flow of the stream must be preserved irrespective of the load, and a pair of Pelton-Doble oil-operated governors of 5000 ft.-lb. capacity. The corners of the exhibit are marked by posts, of which examples of the monitors, or giants, largely used in hydraulic mining are a feature. After a half-day spent in this exhibit the Martian would have something to tell the folks.

Whether distance and the decline of the international exposition as an agent of publicity and good will was a reason or an excuse, whether commercial unpleasantness followed by the present deplorable condition is the principal cause, there are few foreign exhibits in the power-plant line. Some of the well-known inventors and builders of the Old World are present in name and in Americanized examples of their product: the Swiss Sulzer Bros., for example, in the Busch-Sulzer-Diesel engine; the Swedish in the McIntosh-Seymour-Diesel engine and in models and parts of the Ljungström turbine exhibited in the Swedish pavillion by the Svenska Turbinfabriks Aktiebolaget of Finspong; the German, Dr. Adolph Diesel, in several engines of the type which bears his name, as well as Otto, whose name characterizes the other type; the distinguished French savant and inventor, Maurice La Blanc, in the Westinghouse-La Blanc air pump; Wilhelm Schmidt, another German, whose name is inseparably connected with the development of the superheater and whose type of this apparatus is exhibited by the Locomotive Superheater Co.; and the English Sir Charles Parsons, in the Westinghouse-Parsons turbine. A sign upon the wall in the French section of the Manufactures Palace indicates that the Société Générale de Constructions Mécaniques will exhibit some Rateau products.

For the paucity of the larger exhibits by American builders remoteness may be a sufficient reason, but this can hardly account for the absence or inadequate representation of so many American makes of small instruments and appliances. The only engine indicator exhibit is a case of Trill's in the space of the Bessemer Engine Co. The booths, with their shining instruments in rosewood boxes, with inside and outside springs, continuous-diagram drums, reducing wheels, planimeters, etc., which are so attractive a feature even of the convention exhibitions for the visiting engineer, are completely lacking. There is not a flue-gas analyzing apparatus nor a CO_2 recorder to be found about Machinery Hall, but some are said to be in use in the Bureau of Mines exhibit and exhibited among the chemical apparatus. The National Tube, Crane and Lunkenheimer companies have representative exhibits of pipes, valves, fittings and specialties. Lagonda has the tube-cleaning field to itself with an excellent presentation of its products, and the Bristol and Industrial (or, as it is now, Foxboro) Instrument companies have creditable exhibits of indicating and recording appliances. There are quite a number of oil burners entered, but the most attractive and best-displayed are those for domestic and industrial purposes requiring small capacity. There are a Cochrane metering feed-water heater and a Lea V-notch recorder as parts of composite exhibits, and a Hoppes ditto, not yet out of the box, evidently waiting for installation with the Badenhausen boiler. No economizers, no chimneys, no forced-draft apparatus, no smokeless furnaces, no damper regulators or systems of furnace control, no steam-flow meters, but a General Electric flow meter measuring the hot water circulated in the heating system of the Horticultural Building. Feed-water purification and scale prevention are represented only by the Permutit Co. and Acheson Graphite. There is a notable absence of steam packings, both metallic and soft. Of boiler-feed pumps there are the Marsh and a few centrifugals which might be used for

this purpose, but which are not entered as such; of vacuum pumps, only the La Blanc and a small power-driven Marsh, not sectioned.

If our observing friend from Mars were really curious and inductive he might wonder, as he stood beneath the glistening Tower of Jewels and saw the brightly illuminated statuary, the thousands of lights playing upon and gleaming within the buildings, the cascades and fountains, the machinery in motion, where all the power came from of which all of these are manifestations. And here he would put his finger upon the feature in which this Exposition, from the power-plant point of view, is most representative of present-day tendencies and practice—the obliteration of the isolated plant and of the industries dependent upon it by the central station. This Exposition does not make its power, it buys it.

The Palace of Machinery

The Palace of Machinery, with some of its sculptural embellishments, is shown in Fig. 5. It is said to be the largest timber structure ever erected—967.5 ft. in length, with an extreme width of 367.5 ft., built in three long naves, each 75 ft. wide, with three transverse naves. Some 7,500,000 ft. b.m. of lumber and 1500 tons of structural steel were used in its construction. Its architecture was suggested by that of the baths of Emperor Hadrian, at Caracalla. It was the first of the Exposition buildings to be completed, and it is a pleasure to remark in passing that President Moore fulfilled his promise to have the Exposition complete on the opening date, at least as far as the grounds and buildings are concerned. Considering the fact that more than half the orders for space had been canceled before the end of October, and the difficulties attending the preparation and transportation, especially of foreign exhibits, on account of disturbed conditions, financial as well as otherwise, the degree of preparedness and of representation in the exhibits themselves is remarkable. Some idea of the spaciousness and the interior of the Machinery Building may be gained from the fact that Lincoln Beachey made a flight inside of it with an aëroplane. Panel IV of Fig. 5, taken before the exhibits were installed, shows the heavy framing with the lattice timber girders left open. The pillars supporting the arches of doorways are treated to represent the more vividly colored Sienna marble, and are surmounted by Haig Patigain's heroic-size statues of the four powers—Steam, Electricity, Imagination and Invention. About the bases of the smaller columns in the vestibule and doorways are friezes, and in the triangular spaces above the doors spandrels of industrial workers by the same artist, reflecting the purpose of the building. In the western plaza before the main entrance is Daniel Chester French's monument to the Genius of Creation.

⁂

Hydraulic Cement has been made for centuries in India and Burma by mixing pure slaked lime and "soorkhee," a finely powdered red brick. A mixture of one-sixth underburnt "soorkhee," one-sixth well-burnt "soorkhee," one-third slaked lime and one-third sand makes a dense, waterproof mortar.—"Engineering News."

⁂

Gun Metal Composition—The Admiralty specification for gun metal, extensively used for valves or valve seats, is 10 per cent. tin, not more than 2 per cent. zinc, and the remainder copper. This makes a tough alloy when cast, but it will not forge, having a tensile strength of 28,000 to 35,000 lb. per sq.in. and an elongation of 10 to 15 per cent. in 8 in.

JUST FOR FUN

How It Happened

(Epitaph in Girard, Penn., Cemetery.)
In Memory of
Ellen Shannon
Who Was Fatally Burned
March 21, 1870,
By the explosion of a lamp filled with
R. D. Danforth's
Nonexplosive Burning Fluid.

⁂

Two Kinds of Waste Confused

"The Boss is on the war path, kickin' sumpin fierce; expenses las' munth went soarin. Things are goin' to waste, he sez. So he hired one uv them 'efficiency' fellers to fine out where the waste went tuh.

SIDE ELEVATION OF "SKINNY" AND HUMP ON "EFFICIENCY"

"Now, me—I'm no egspert, but if the Boss wud ony ask me, I cud tell him where mos' uv the waste goes in this place. 'Skinny,' there, he's got his locker heapin' full uv waste."—John Muldowney, New York.

⁂

Boilers Not of Camel Variety

An engineer in charge of a small power plant, desiring the services of a fireman for night duty, put an advertisement in one of the local newspapers. After receiving numerous applications one was chosen which appeared to be good and the applicant was requested to report to the plant for duty. After meeting the engineer the new fireman was introduced to the day man, with whom he spent about an hour before relieving him.

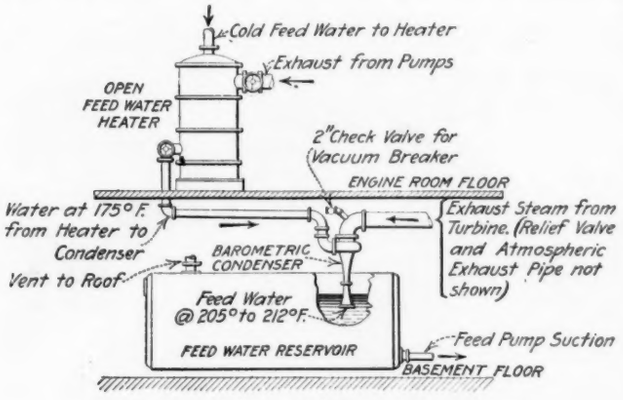
The engineer, who lived near the plant, was awakened during the night by the low-water alarm whistles blowing continuously, and he immediately reported to the boiler house to investigate. Finding no water in sight, he said to the sleepy fireman: "There is no water in the boilers!" "Oh, yes there is," replied the fireman. "How do you know there is?" questioned the engineer. "Because the day fireman filled them both before he went home," was the laconic reply.—C. E. Kling, New York City.

Barometric Condenser Used as a Water Heater

By K. M. Gilbert

In a power plant of about 15,000 hp., the feed water was heated in an open heater into which the auxiliaries exhausted. The temperature reached was only 175° F., which was uneconomical.

There was at this time a 350-kw. turbine generator running condensing. The chief engineer decided to operate this unit at atmospheric exhaust pressure and to use the heat in the exhaust steam for the feed water. But the open heater was too small to condense this extra amount of steam, and there was no available space in which to install another heater. Finally, it was decided to change the exhaust piping and place the condenser over the reservoir as shown in the illustration. In this position the water could flow by gravity from the heater to the condenser, where it would come in contact with the exhaust steam. The latter would be condensed in the same manner as when the turbine was running


Cold Feed Water to Heater
Exhaust from Pumps
OPEN FEED WATER HEATER
2" Check Valve for Vacuum Breaker
ENGINE ROOM FLOOR
Water at 175° F. from Heater to Condenser
Exhaust Steam from Turbine. (Relief Valve and Atmospheric Exhaust Pipe not shown)
BAROMETRIC CONDENSER
Vent to Roof
Feed Water @ 205° to 212° F.
FEED WATER RESERVOIR
Feed Pump Suction
BASEMENT FLOOR

LAYOUT OF FEED-WATER HEATERS

condensing and as if a vacuum were obtained in the exhaust pipe.

There was some difference in opinion as to just how, with this arrangement, the condenser would work. It was contended that the steam would not be condensed rapidly enough with injection water at 175° F., also that the water would not flow out of the tail pipe at a sufficient rate to keep the exhaust pipe free from water. These fears were groundless; the condenser has worked satisfactorily for more than a year without requiring any attention whatsoever.

The condenser heats about 1000 gal. of water every minute, raising the temperature from 175 deg. F. to an average of 205 deg. F. (at times the temperature is 210 deg. F.), an average change of 30 deg. This is equivalent to putting 243,000 B.t.u. per minute into the feed water. This is not all clear gain because the turbine requires about 20 lb. more steam per kilowatt hour when running noncondensing than when condensing. This extra steam consumption amounts to about 116 lb. of steam per minute, equivalent to about 116,000 B.t.u. The net gain per minute due to operating the turbine noncondensing and using the exhaust for the feed water is, therefore, 127,000 B.t.u. From each pound of coal burned in the plant, 9500 B.t.u. are given to the feed water, so the equivalent fuel saved is $\frac{127{,}000}{9500}$, or 13.36, lb. per min. This amounts to 800 lb. per hr., and for 300 working days of 24 hr., is nearly 3000 tons of coal per year.

This use of a barometric condenser may not be new, and there is nothing astonishing about the scheme; nevertheless it illustrates how one engineer "made good" by operating his plant at a fuel cost very much lower than his predecessor was able to do. Furthermore, he was able to do this without buying any new apparatus and by simply rearranging what was already installed.

Largest Lenix Drive in the United States

An interesting example of what can be done when the centers of the driving and driven shafts are closer than is generally assumed to be good practice, is to be found at the works of the Hastings Pavement Co., Hastings-

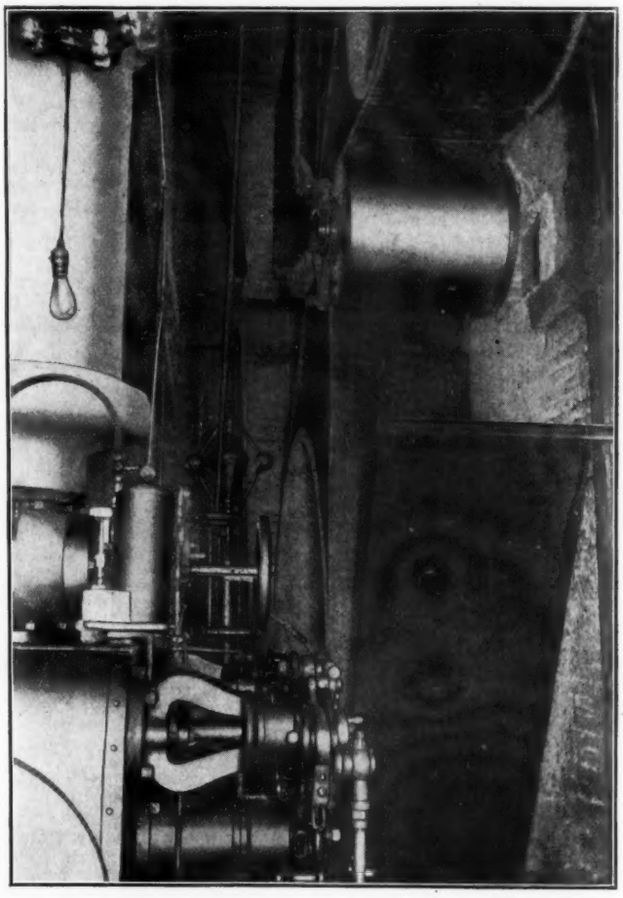


FIG. 1. LENIX DRIVE AT THE HASTINGS PAVEMENT CO.'S PLANT

on-Hudson, N. Y., which has a capacity of 80,000 asphalt paving blocks per day.

In this plant the main engine, with an 18x42-in. cylinder, was designed to develop 250 hp. with ¼ cutoff at 100 r.p.m. The engine as now operated carries an average load of 300 hp.

The diameter of the driving pulley is 12 ft., that of the driven pulley on the lineshaft is 62⅞ in.; a 30-in. two-ply leather Duxbak belt is used with a distance between centers of but 16 ft. The face of the pulleys is 31 in.

In order to obtain sufficient arc of contact of the belt with the smaller pulley it was necessary to utilize an

idler or tightener pulley of some sort. Although such an arrangement with ordinary bearings might have been used, it was thought advisable to install a Lenix drive (F. L. Smidth & Co.) of 350-hp. capacity, the largest so far built in the United States. The drive is illustrated in Fig. 1, and details are shown in Fig. 2. Here, the old established rule of allowing not less than 20 to 30 ft. between centers with wide belts is disregarded. With a shaft measurement of 16 ft. center to center, the arrangement as shown in Fig. 2 gives an arc of contact on the driving pulley of 234 deg. and on the driven pulley of 213.5 deg.

The drive is held against the loose side of the belt by a counterweight and rope, as shown. The steel counterweight box is 27 in. high and 18x8 in. cross-section and is filled with sufficient scrap iron to give the required tension of the drive on the belt. The effort of the counterweight is not exerted against the belt alone, as it must counterbalance the weight of the drive, the difference in weight between the two being that which acts on the belt.

As a protection against serious accident in case the counterweight rope should break, a turnbuckle and chain are attached to the drive at one end and secured to the timber structure at the other end.

Bearings for an arrangement of this type are subject to hard usage, and to prevent trouble those of the drive are of special design and are self-oiling. The inner shell has a ring of holes around the circumference, in which is wicking soaked in oil, which keeps the bearing properly lubricated. This arrangement of wicking and the design of the bearing permit of placing the drive in any horizontal position without interfering with the lubrication of the shaft.

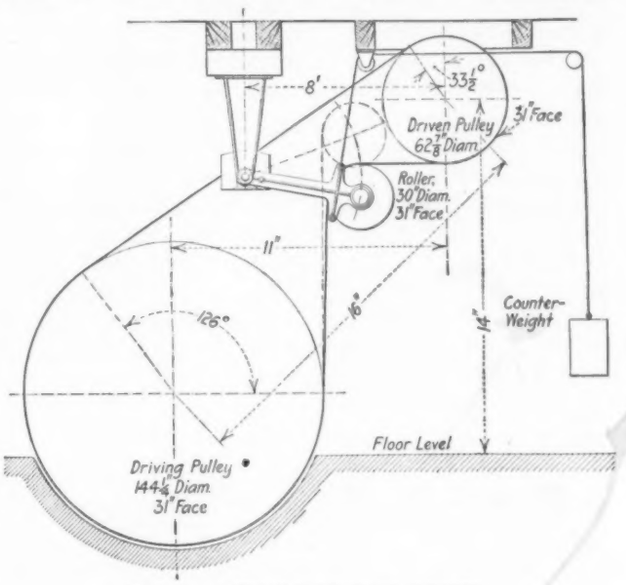


FIG. 2. DETAILS OF THE DRIVE

Visits of Inspector Brown--III

By J. E. Terman

SYNOPSIS—The Chief imparts a few pointers to Brown on the bracing of boiler heads. Brown gives the Chief his idea regarding the holding power of loose stays.

For about a week after the Chief had talked to Brown about the stresses on boiler patches, the latter had thought over various problems of a similar nature connected with the stresses in different parts of a boiler. As the Chief came into the office one morning, Brown stopped him as he passed his desk, saying, "Chief, I want to know why it is that we inspectors are always expected to report whether the braces in a boiler are taut or not."

"Well," answered the Chief, "you don't mean to tell me that you think a loose brace is a proper one to be depended on in a boiler, do you?"

"A week ago," said Brown, "I would have been able to answer that question right off the bat, but since our talk about the stresses in boiler patches I have not felt so sure about answers to questions of this kind. It seems to me that a certain amount of looseness might not be a bad thing."

"How do you make that out?" asked the Chief.

"Well, if the head of a boiler was not supported by braces at all it would have some strength to resist pressure on it," said Brown, "and I notice we don't add any value to the bracing on account of the strength of the head. I have been trying to figure out why this is not done, and I believe I have found out why. I know that in order for the head itself to take any considerable portion of the load produced by the steam pressure on it, it would be necessary for the head to change its shape, but since the braces tend to hold it in its original position it cannot change shape and, therefore, cannot take a portion of the load, but the load must be all carried on the braces. On this account, I have thought that if the braces could be arranged so that they would be a little slack and would not begin to take their portion of the load until the head itself had all the load it should carry, the combination of braces and head might be much stronger than if all the braces were taut."

"Well," said the Chief, "you have begun to show signs of using your head in your work for something besides butting it against those skimmer attachments known as inspectors' hurdles. It begins to appear that we can make a real boiler inspector of you in the course of time.

"Your contention is perfectly correct, that loose braces and the head to which they are attached might work together as a team much better than if the braces were all taut, but the difficulty is to get the braces loose just the right amount. If someone could discover a brace material that would act just the same as steel until it was stressed nearly up to its true elastic limit and then begin to stretch very rapidly with small additional loads, the safe working load that could be allowed on braces would be much higher than it is.

"In supporting a pressure load without braces a boiler head tends to dish out and the amount of movement is,

of course, different at various parts of the head. In order to have the looseness of the braces accommodate this movement, each brace would have to be arranged to suit its particular position on the head, which would be practically impossible.

"Loose braces are not so commonly found in boilers today as they were a number of years ago, when the old pin crowfoot type of brace was in common use. It was usual to find such braces loose, owing generally to the fact that they were too lightly constructed to be able to carry all the load alone, and as the jaws were often fairly wide apart, the pins would bend and allow the boiler head to do its share of the work in retaining its place in the shell.

"It is, of course, true that with a solid crowfoot type of brace as commonly used today, the boiler head in many cases may take a very considerable portion of the load, for the braces stretch as the load comes on them and this allows the head to take some of the load, but you can easily see that there is no way to determine, even approximately, how much of the load the head may carry in a given case; its strength, therefore, cannot be considered in the problem.

"The fit of the braces and their position on the head of a boiler make an estimate of the load carried by each individual brace a most difficult matter, and it is for this reason that the allowable working stress on brace material is so conservative.

"The low value allowed on the diagonal crowfoot type of brace has also been for the purpose of taking care of the added stress on this type, due to their angular position with respect to the direction in which the load is applied. Bracing is one of the biggest problems connected with boiler design, and we will probably have occasion to discuss the various features connected with this subject in the future."

Lanz Locomobiles and the War

SYNOPSIS—The Lanz locomobile is familiar to our readers, having been described and illustrated in previous issues. It is well known that it is a convenient unit for moving from one point to another, which not only makes it suitable for permanent installation in power plants, but enables the user to install it as an emergency unit.

The European War has given the locomobile an opportunity to demonstrate its usefulness in the war zone, where it is being used for power production for numerous purposes. Several such installations are illustrated herewith. The engine can be installed quickly and without costly buildings, as the boiler, engine, pipe lines, pumps and all auxiliaries are combined in one unit.

On the other hand, factories that have to considerably reduce their production have added locomobiles to their power plants, because they have to work with such small loads that their main prime movers are too large to work economically and the saving of fuel warrants the installation of a smaller unit.

Factories and generating stations equipped with gasoline or oil engines found themselves in a dilemma because the supply of fuel oils at hand in Germany was commandeered by the army and navy, some oils obtained by import were not available at all and for others the prices were prohibitive. Such plants could solve the problem by installing locomobiles, for which coal fuel can be obtained at fair prices during the period of the war.

The accompanying illustrations show a few installations, made since the beginning of the European War, which demonstrate the adaptability of the locomobile of the portable and stationary types to the new conditions that have been created. They are being used for wireless-station service in capacities as high as 200 b.hp.

Fig. 1 shows two 580-b.hp. locomobiles which have been added to the power plant of a large arms and ammunition factory and which operate with a total output of 3500 b.hp.

One of the largest types of Lanz locomobiles is shown in Fig. 2. This superheated-steam, compound-unit has a normal capacity of 650 b.hp. at 200 r.p.m. and a temporary maximum output of 880 b.hp. Its construction, with a three-phase generator rigidly coupled, is in conformity with the construction of all the larger Lanz units. The crankshaft rests on two cast-iron standards. The removable tubular boiler has two furnaces and is equipped with automatic stokers. This locomobile is installed in the power plant of a large gun factory.

In another case the commandeering of the fuel oil forced a municipal power plant to change from oil engines to steam power, and a 120-hp. locomobile met the emergency.

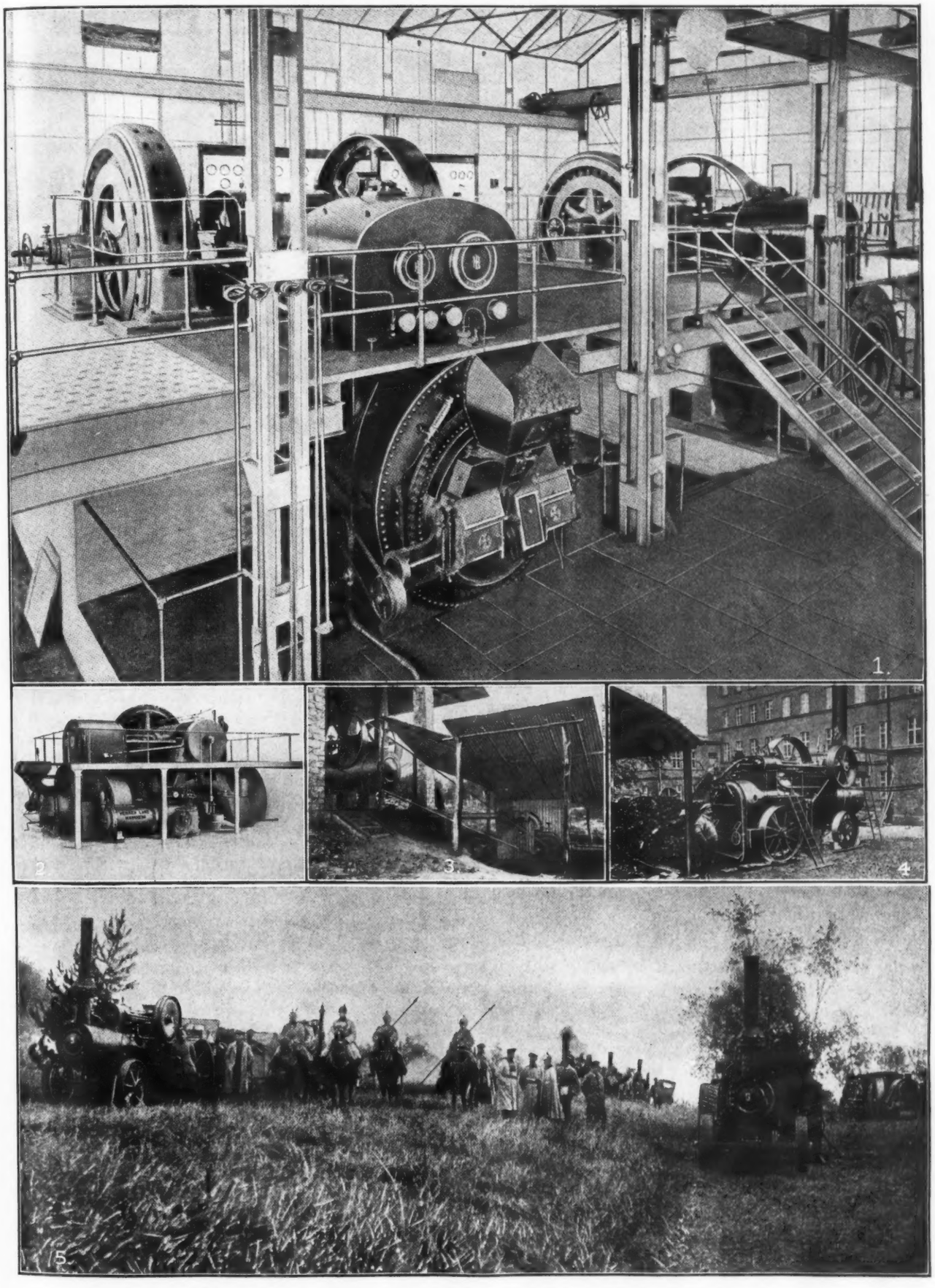
A large field for this type of unit was offered by the necessity of installing pumps right in back of the firing line. Pumps to drain the trenches to enable the soldiers to remain in them are driven by the locomobile. Fig. 3 shows a centrifugal pump so driven.

The moats of the conquered forts of Liége were emptied by the aid of locomobiles, and these are now used for supplying the searchlights with current. Fortifications were built by their aid, and they also proved a valuable help to the engineer corps of the army in railroad and bridge work. On account of their high efficiency Lanz boilers were installed for heating purposes in hospitals and prisoner camps. The Austrian Red Cross has two such boilers with a total of 1300 sq.ft. of heating surface supplying steam for 7500 sq.ft. of radiating surface.

For heating the extremely long hospital trains, which could not be done from the locomotive, a heating car was coupled in the middle of the train. This car is equipped with a locomobile boiler of 250 sq.ft. of heating surface and carrying 90 lb. pressure.

For the aviator corps several boilers for hot-water supply were furnished. Industrial plants in the occupied territories, in cases where the prime movers were destroyed by the shells, have been equipped with portable units, installed in the yards and worked on the countershafts of the plants until the engines could be repaired or replaced. Fig. 4 shows such an arrangement.

Fig. 5 shows a transport of supplies, guns and ammunition by tractors, which are covered with branches to prevent their being seen by aviators.



FIGS. 1 TO 5. APPLICATION OF THE LOCOMOBILE IN THE WAR ZONE

Fig. 1—Two 580-hp. units added to the power plant of an arms and ammunition factory. Fig. 2—Large size of locomobile. Fig. 3—Centrifugal pump draining a trench. Fig. 4—Portable unit driving a factory. Fig. 5—Tractor and transport of guns and ammunition; the shrubbery is used as a disguise

Oil Troubles Experienced in the Refrigeration System

By A. G. Solomon

SYNOPSIS—The oil trap will catch more oil if placed near the condenser than if close to the compressor, because at the latter place much of the oil is in the form of vapor. Examination of the stuffing-box and packing is most important if trouble is to be avoided. The article tells how. Individual lubricators for each machine are better than a central one for all.

One cause of lost refrigerating capacity is oil in the system. Oil which goes into the ammonia compressor for lubricating purposes finds its way through the whole system.

Some machines have a small oil separator, arranged with baffles on the discharge line, and this is supposed to trap all the oil. One mistake frequently made is to have this separator close to the compressor, where the temperature of the discharge gas is at its highest. Much of the oil that travels with the ammonia is vaporized, and of course the oil trap catches only the liquid. If this same trap is placed in the discharge line close to the condenser, much more oil is caught. The reason for this is that some of the heat of compression is given up to the surrounding atmosphere and the oil vapor condenses back into a liquid. Therefore place the oil separator as close to the ammonia condenser as possible.

A gate valve or a straight-way cock should be placed close to the separator on the oil blowoff line. This valve or cock should be opened wide and another, placed in a convenient position, should be used for allowing the oil to be drawn out. The object of the first valve is for emergency use in case bits of packing get into the draw-off valve and prevent its closing.

If the fit of the bushing in the back end of the stuffing-box or of the oil lantern is not as it should be on the ammonia rod, the packing will be drawn through and find its way to the oil trap.

Examination of the Rod Packing

While writing of rod packing it is well to make it plainly understood that the kind of packing used and the care given to it is the real point to be considered when the question of oil in the system is studied. In nearly all cases the oil that passes into the evaporating coils of a refrigerating plant is intended for the lubrication of the rod packing. If the packing is inferior it will take more oil to keep it in running condition than if good packing is used. Poor packing will either cause the rod to run hot or allow ammonia to escape. In extreme cases ammonia escapes even while the rod is smoking hot. When packing and rod trouble is met with it is the common practice to use much oil to overcome it. This is a mistake. When the trouble begins and a greater amount of oil is needed, the proper thing to do is to look for the cause of the trouble. Pull out the packing and note its condition. If it is not as good as it should be, throw it away. Examine the rod for rough spots and for cuts. Often, when packing a rod the engineer uses a hard hammer to drive the packing, and the rod is then marked. Such marks will cut the packing and cause leakage, no matter how tight the gland is. If a hammer is necessary, use one made of copper, babbitt or raw-hide. If the rod is in good condition, caliper the stuffing-box with the piston in different parts of the stroke. See that the rod is central in the stuffing-box throughout the travel. Then notice the fit of all openings through which the rod passes, including the openings in the crank-end cylinder head, the oil lantern and the gland. All these should be a neat sliding fit on the rod and should be babbitt-lined to prevent scoring. The oil lantern must also be a snug fit in the stuffing-box or it will bear on the rod.

Stuffing-Box Relief Openings

On most compressors there are two ½-in. openings in the stuffing-box—one at the bottom for the admission of oil to the lantern from the lubricator, the other from the top of the stuffing-box and connected to the suction line. This is to relieve the lantern of any ammonia which passes the packing at the back half of the stuffing-box. It provides for suction pressure only on the packing between the lantern and the gland. No ammonia should pass through this line, and it will not do so if the packing back of the lantern is good. Leakage through this part of the packing is just as harmful as leakage in the piston rings or compressor valves. It causes the compressor to handle the same ammonia over and over again. This gas line is provided with a globe valve, which should be open at all times except while packing the rod or pumping down below atmospheric pressure. If the packing becomes cut, small pieces are sent into this line and will lodge in the valve and choke it. This will allow the condenser pressure to accumulate in the oil lantern and cause leakage past the gland. When packing the rod, see that this gas line is clear. Oil for the lubrication of the piston and compressor valves also passes through this line.

When the rod packing is not as good as it should be and a large quantity of oil is used, it finds its way into the compressor and from there is discharged with the ammonia. It must then be caught in the oil traps. The trap on the discharge line is the most important oil catcher, and it must be emptied whenever necessary, to prevent the oil from going into the condenser. What oil goes by this trap gradually works through the condenser and liquid lines and into the evaporating coils. Here, its insulating effect is made known by decreased refrigerating capacity.

In some installations oil traps are also placed in the liquid lines between the liquid receiver and the evaporating coils. In brine and ice tanks an oil blowoff line and valve should be placed in the bottom manifold, and these should occasionally be tried for oil.

On the lowest place of the direct expansion piping there should also be an oil blowoff, and this can be made in the form of a trap by using a piece of 3- or 4-in. pipe about two feet long. A lot of oil will be caught in such a trap.

The next place where oil can be drawn off is in the suction line close to the compressor. A trap here must be emptied at regular intervals. The best time to empty the one on the discharge line and the one on the suction is immediately after the system has been pumped down. The lowered back-pressure will cause a lot of oil to be drawn from the evaporating coils, and it will lodge in the traps. The most desirable time to empty the traps on the direct expansion piping and the bottom manifold of brine or ice tanks is when the temperature is the highest. To keep the system as free from oil as possible will require constant attention. Care must be exercised in the amount of oil used on the rods, and this, as well as the oil drawn out, should be measured. Measuring will tell the engineer whether the system is filling or not. If it is found that a noticeable amount of oil is being put into the coils and not caught at the traps, the evaporating coils should be blown out with steam and air at the first opportunity. The oil in the coils of the ammonia condenser can be loosened by simply shutting the water off one stand at a time and allowing it to become hot from the discharged gas.

Some ammonia compressors are provided with lubricators or hand pumps that admit oil directly into the cylinder. In most cases these are unnecessary, as there is enough oil circulating with the ammonia to sufficiently lubricate the valves and piston. Do not put more oil than necessary into any part of an ammonia system.

Central Lubricators Not Desirable

In some plants, especially where there are several compressors, one large lubricator is used for all ammonia rods and for cylinder lubrication. These lubricators often hold five or ten gallons, and as they are usually filled by means of a pump, the operator becomes careless and uses much more oil than necessary. It is also an easy matter to shut off the oil from a compressor that is being pumped down below atmospheric pressure, and the result is that the contents of the large lubricator are discharged into the system. For this reason the practice of using small individual lubricators for each rod should be encouraged. Small lubricators or oil cups are also replacing the belt-driven oil pumps formerly placed on each rod.

Ammonia regenerators or purifiers are also good for the removal of oil without losing ammonia. Another way to prevent loss of ammonia when drawing off oil is to empty the high-pressure oil trap into a small receiver which has a connection with the low-pressure side of the system. In this way the ammonia is taken from the oil by the reduced pressure, which causes evaporation.

Opposition to the Use of Steam for grinding corn was encountered by Boulton and Watt (1780 and later) because it was claimed that steam power would throw wind and water mills out of work, take away employment from laborers in hand-operated mills and, strangest of all, reduce the price of bread.

Hard on American Coal—In the "Jupiter," as the collier was named, the machinery installation developed a total power of about 7000 hp., and the coal consumption was 1.66 per s.hp.-hr. This figure may not seem to indicate any exceptional economy, but it has to be borne in mind that the coal employed was comparatively low-grade American fuel, and the result is, in fact, said to have been better than was anticipated by the builders.—"The Times (London) Engineering Supplement."

Oh, those penslips!

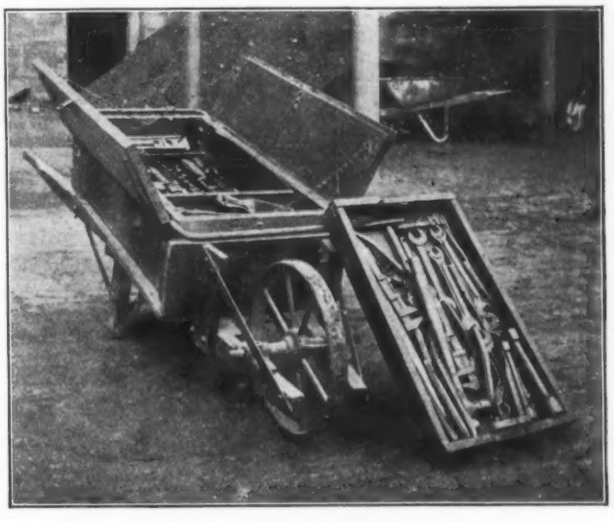
Emergency Portable Repair Kit

One hundred cents a minute, $60 an hour, $1380 a day—that is the loss incurred by the Hastings Pavement Co., manufacturers of asphalt paving blocks, Hastings-on-the-Hudson, N. Y., for every minute, hour or day the works are shut down. Twenty-three hours constitute the working day of this company.

In order that the loss of time from breakdowns may be reduced to a minimum, the portable emergency repair kit illustrated herewith has been devised. It consists of an ordinary dirt-wheelbarrow frame, which is boarded across from handle to handle, has an end piece next to the wheel, which is braced, and a tool box of a size to fit on the wheelbarrow. This box has a heavy iron handle at either end to permit of carrying it to points where it would be impossible to run the barrow. The cover is made in two parts, hinged at the sides and prevented from opening too far by small chains.

The bottom of the box is for heavy wrenches, cold-chisel, hammer and the like. Light wrenches of various sizes and shapes and other small tools are kept in a tray.

The handles of these tools are painted red to distinguish them from others, and the standing order regarding them



PORTABLE REPAIR KIT

is that they shall always be returned to the kit no matter where found and that they are to be used for emergency work only.

When the outfit has been used it is the duty of one workman to thoroughly clean the tools, sharpen dulled cold-chisels, oil the threads of the monkey-wrenches and see that everything is ready for the next emergency call. The barrow kit is then locked and placed in a shed near the machine shop. The advantage of this contrivance is that all necessary tools are handy and there is no running back and forth to the machine shop for this, that or the other thing, while making repairs.

The fire drill instituted by this company is of interest. In case of fire every man goes to his station and performs the duty that has been assigned to him. There is no confusion—every man knows just what he is to do, and (as in the case of an early morning fire) the fire-fighting apparatus is handled about as orderly as if a drill were taking place.

To prevent misunderstanding as to who should occupy any particular station, each employee is given a printed

slip, on the back of which he must sign his name and designate his station in the fire drill before drawing his pay. The position given on the slip is compared with a key card on which is a list of the various stations, giving the names of the men assigned to them. All fire apparatus is inspected each week by an assistant foreman who makes a written report before receiving his pay.

New York City Heating Costs*

Operating costs for heating six New York City buildings are given in the accompanying tabulation. As all are largely heating plants, the load is subject to all the vagaries of the weather. The extremely variable loads of the early spring and fall, with the excessive standby losses and transient labor force, are in part responsible for the low evaporation. The high cost of steam per 1000 lb. does not mean a high total cost for the season. Out of the 5040 hr. (Oct. 1 to Apr. 30) making up the nominal New York heating season, steam is actually needed from 3000 to 3500 hr., in buildings occupied from 12 to 18 hr. daily. This small total consumption results in a low total cost for the season, in spite of the unit cost.

COST OF STEAM IN HEATING PLANTS

Number of building	1	2	3	4	5	6
Number of days	15	4	5	4	46	151
Steam gen., 1000 lb.	1611	362	485	124	10,310	36,890
Tons of coal, gross	117	27.6	30.3	11.3	783	2540
Rate of evaporation	6.15	5.84	7.13	4.94	5.89	6.31
Av. outside temp.	30.7	34.2	39.6	37.0	34.8	40.9
Boiler capacity, hp.	384	600	600	800	1200	900
Max. boiler hp. del.	280	300	330	150	600	850
Av. boiler hp. del.	100	80	150	50	235	350
	Cost per 1000 lb. of Steam					
Coal	$0.191	$0.201	$0.165	$0.238	$0.203	$0.187
Labor	.049	.085	.079	.251	.052	.056
Ash removal	.010	.011	.009	.021	.008	.007
Water (makeup)	....	....	....	....	.007	.001
El. cur. (forced dr.)	.014	.005	.007	.021	.008	.006
El. cur. (b.f. pump)	....	....	.007	....	....	....
Supplies	.004	.011	.006	.002	.004	.006
Repairs and misc.	.004	.004	.002	.001	.003	.002
Total	$0.272	$0.317	$0.275	$0.535	$0.285	$0.265
Fixed charge on investment	.029	.051	.054	.084	.044	.033
Total cost per 1000 lb.	$0.301	$0.368	$0.329	$0.619	$0.329	$0.298

In several instances where the results cover a short period, the apparatus for weighing coal and water had but recently been installed. Such tests do not, of course, represent the performance throughout the year, but do convey an idea of the possible economy. In all the plants No. 3 buckwheat coal delivered at $2.50 a ton is burned with a balance draft.

No. 1 is a 25-story office building, covering a plot about 9000 sq.ft. The boiler plant, consisting of two Heine water-tube boilers operated at 70 lb. pressure, supplies steam for cooking, heating and hot-water service. The plant is shut down during the summer and the steam for cooking purchased.

No. 2 is a large, 12-story loft building containing about 4,000,000 cu.ft. Steam is used for manufacturing in large amounts throughout the year, 24 hr. a day. The boiler plant is made up of three fire-tube units.

No. 3 is a new office building 25 stories high, with a volume of about 6,500,000 cu.ft. The equipment for heating and hot-water service consists of two Erie City water-tube boilers, operated at 30 lb. pressure. The boiler-feed, vacuum and sump pumps are operated by electric motors. The boilers are shut down during the nonheating season and hot water is supplied by a small heater.

No. 4 is a loft building in the old commercial section of New York. This building has only recently had supervisory service. The figures show extravagance in the labor costs and the use of forced draft in burning the coal. This case illustrates the too frequent condition where continuity of service is the only consideration given the power plant.

No. 5 is a large department store of about 15,000,000 cu.ft. contents. Four B. & W. water-tube boilers supply steam for cooking, refrigeration, operation of a cash-tube system, hot water and heating.

No. 6 receives steam from a boiler plant 750 ft. distant. The load is fairly constant day and night during the heating season. The plant is operated (only when heating is required) by three B. & W. units at 100 lb. pressure. The boiler-feed water comes from a heater at a temperature well over 200 deg. F. The load conditions and the general design for this plant permit fairly satisfactory operation, as may be seen from the costs.

*From report of the Station Operating Committee, National District Heating Association, read June 3 at Chicago.

Will Quizz, Jr.

SYNOPSIS—Will Quizz, Jr., wants to make the acquaintance of acceleration due to gravity, which introduction is supplied by Chief Teller ***in his own*** *way.*

"Chief, I don't get this acceleration by gravity symbol g connected up right somehow. Since it enters into so many formulas, I ought to become more familiar with it, I guess. Can you give me some help to get it fixed in my mind, so it will stay put?"

"The way I like to think of acceleration, Will, is that if a ball weighing one pound were suspended in space and continuously pushed or pulled with a force of one pound, it would gain velocity at the rate of about 32 ft. per second. This is really the condition of a body falling freely. It is suspended in space and gravity is pulling upon it with the force of one pound for each pound of its weight, so that it is accelerated, or gains velocity, at the rate of 32 ft. per second. At the end of the first second it is moving at the rate of 32 ft.; at the end of two seconds 64 ft., and so on, adding 32 each second.

"It is for this reason that this acceleration of 32.16 ft. per second, to be more exact, is called the acceleration due to gravity, and is known and denoted in books upon physics and mechanics by the letter g.

"It is evident, then, that the force necessary to get up a given velocity in a body increases directly as the velocity and weight and inversely as the time of its application, and may be expressed by

$$Force = \frac{velocity \times weight}{32.16 \times time}$$

The space through which a body will move in a given time is the time multiplied by the average velocity. The average velocity of a body which starts from rest and gains velocity uniformly is one-half the final velocity.

"To find the space or distance through which a body would move in starting from rest and getting up to a given velocity, when the increase of motion is at a uniform rate, we have simply to multiply the time required by one-half the given velocity

$$Space = \frac{time \times velocity}{2}$$

"Energy is the product of force and space. By multiplying the formulas for force and space we get a formula for the energy required to get a body of a given weight into motion at a given velocity.

$$Energy = force \times space$$

$$E = \frac{velocity \times weight}{32.16 \times time} \times \frac{time \times vel.}{2}$$

In doing this the time cancels out, leaving

$$E = \frac{W V^2}{2 g}$$

or for each pound of weight the energy required to get up a given velocity is

$$E = \frac{V^2}{2 g}$$

"Notice that the energy required increases as the square of the velocity. To get a body moving twice as fast requires four times as much energy and three times as fast, nine times as much energy."

Editorials

Discontent in American Society of Mechanical Engineers

Whether he be honestly concerned for the future of the society, just naturally peeved, or attempting to ride into the presidency on a wave of discontent, Harrington Emerson has incited, inspired, induced and collected something over a hundred complaints of the way in which the affairs of the American Society of Mechanical Engineers are administered, by circularizing a membership of over five thousand. It would be phenomenal to find a membership of this size who were entirely satisfied, and the expression of such dissatisfaction by such a number means its wider existence.

The collection of anonymous growls and kicks distributed in printed form just previous to the Buffalo meeting may be roughly classified as follows: The clique idea; frigidity at headquarters; the conduct of the *Journal*; the threatened abandonment of "Transactions"; charge for entertainment at the annual meeting; the campaign for the increase of membership; nomination and election of officers.

The clique idea is to the effect that the society has fallen into the hands of a self-perpetuating select circle who are exploiting it to their own advantage. Its proponents point out that, of an income variously estimated at from fifty to one hundred and sixty-five thousand dollars, not enough is left after the clique gets through with it to send out advance notices of the meetings, print the usual list of attendants, furnish the members with copies of the transactions, entertain them at the annual meetings, etc. "The rent costs nothing," they say; "Andrew Carnegie gave us the building." "The *Journal* costs nothing," they also say, "but is a source of income. Where then does all the money go?" And wild stories of exorbitant salaries to ornamental officers and all sorts of perquisites are current.

A committee has been appointed to investigate the expenditure of the society's funds and the efficiency of the administration. A report from this committee will clean up much of this wondering and blind accusation. Unfortunately, it will not be ready for several months. In the meantime we are informed, by those in a position to know, that the honorary secretary serves, and has always served in that capacity, without any honorarium; that the salaries paid are not in excess of those paid by similar institutions for the same class of service, nor is the number of employees excessive; that those of the staff who frequent the Engineers' Club do so at their own expense; that no automobile is maintained for anybody; that the rent costs more than it used to; that the *Journal* is a source of expense instead of a money-maker, and that the most stringent economy would save very little of the present expenditure. This committee should have a chance to show just what is done with the income and to demonstrate that it is not, as it will naturally be said to be, a committee appointed by the clique for whitewashing purposes.

As to the lack of cordiality at headquarters, *Power* spoke its little piece immediately following the first meeting in the new building.[1] Men who had been members of the society for years and accustomed to the warm personal greeting and genial hospitality of the Thirty-First Street home came into the cold marble lobby of the United Societies Building, were steered up to an undergraduate of some near-by school, asked if they were members of the society—"junior associate or full member," told to "fill out this card, please," handed a cheap but conspicuous celluloid tag and turned loose. There was no place for them to go, they were not "expected" on the headquarters floor—these were the offices. Anybody who strolled into them was made to feel that he was an intruder, and on the evening of the reception when, if ever, these rooms, with their professional relics and interest, should have been open, elevators, by order of the secretary, did not run—for the members—above the sixth floor.

The adoption of this "This is for us, not for you" attitude and the mistaken though conscientious conviction of the secretary that he was the servant of the whole society and could not, in justice to all, give generously of his time to the few who came to headquarters, led to the clique idea as naturally and inevitably as though they had been calculated for that end and adopted with that purpose.

Things are better at headquarters now. The stranger who comes to the eleventh floor and makes himself known will receive the attention due to him as a member; will go away with an idea of what the society has, is like, and is doing, and maybe even with the feeling that occasional contact with the membership is welcomed and enjoyed by those in charge. The headquarters is not, however, nor can it ever be, a club. The complainant in Mr. Emerson's collection, who took his lawyer friend up there to lunch and found a business office, must remain forever dissatisfied. The old house had more of the club features—one could get a sleeping room there; it was open evenings. The headquarters have office hours. The members must learn to recognize the limitations in this respect and not to expect New York club privileges, with all the other advantages and services of the society, for a dollar and a quarter a month.

The other principal causes of complaint are the conduct of the *Journal*, the threatened abandonment of the bound volume of "Transactions," the charging of participants in the recent annual meetings for entertainment which had previously been provided freely, the recent efforts to increase the membership list, the method of nominating and electing officers and, generally, the inadequacy of returns for dues.

The membership will, with a full opportunity to know what the different services involve in expense and curtailed usefulness in other directions, be asked to decide about the *Journal* and "Transactions." The entertainment at the New York meetings, including the noonday luncheons, was never provided by the society, but by the volun-

[1] See editorial, "When the Frost is on the Pumpkin," "Power," Jan. 7, 1908, p. 22.

tary contribution of a small percentage of the local members. They were just as much functions of the meeting as the professional sessions. The opportunities which they offered for broadening acquaintance and intercourse were more valuable than the opportunity to listen to papers that one could read later. The charge, especially for the luncheon, put a different atmosphere upon it. There ought to be facilities in these days of the House Electric to serve a simple, tasty luncheon under conditions which would hold the members together and keep them feeling good, and the society ought to settle all the discussion as to who should pay for it by paying for it itself.

It is charged that there has been an undignified scramble for members in order to increase the circulation of the *Journal* and the income of the clique. What has been done is a matter of record, and the list of names added to the roll can be procured from the secretary. There may be a few lightweights, but there are many among them who ought to have been in the society long ago, but who have been so busy climbing to the positions of trust and responsibility which they occupy that they never would have come in unless somebody had gone after them. There are many other thoroughly qualified but modest engineers, who considered it more seemly to wait until they were invited than to offer themselves for membership. To talk about robbing the cradle is childish. There has been an increase rather than a decrease in the age requirements.

The constitutional amendment providing that any nomination backed by one per cent. of the membership shall have the same standing as that of the Nominating Committee, ought to give everybody who thinks that he belongs in the Council a chance, and does certainly offer plenty of opportunity to oppose self-perpetuating candidates when their perpetuation becomes a disadvantage rather than a benefit to the society.

It is unfortunate that the work of carrying out the ideals and purposes of a great professional engineering society should be hampered by dissension; more unfortunate that there should be any cause for complaint. The best way to restore harmony, unity of purpose and general contentment is a full and free discussion, sifting out those grounds of dissatisfaction which are purely imaginary, and going in a reasonable businesslike way at correcting shortcomings and abuses, if any exist.

Recognizing Ability in Subordinates

Team play is succeeding extreme individualism today in many plants. The "one-man installation," dependent upon the knowledge, health and reliability of a single individual for its successful operation is passing away. Engineers more and more are appreciating the value of their subordinates' service and broad-mindedly giving them credit for distinguished ability. Formerly, many an engineer felt it a reflection on his own attainments unless he received the full credit for everything done in the station, and so reporting the good work of those lower in the ranks was habitually overlooked, but today the trend is away from this attitude.

Progressive managers appreciate particularly a chief engineer able to gather an efficient organization and give him his meed of credit when any under him do something especially commendable. The ability to select capable assistants is worth as much to many engineers with large executive responsibilities as their fitness to handle the machinery of their plants in person, if necessary. The encouragement which recognition of ability gives the younger and less conspicuous men in a plant is beyond computation. We rejoice to see the day in which the "dog-in-the-manger policy" is being condemned throughout the profession in favor of team play with its friendly supervision of men in the lower ranks of station service and mutual recognition of the common demands of the day's work.

An important branch of our naval service devotes itself to the personnel of the fleet and shore stations, recognizing the value of "human engineering" as well as the scientific management of equipment. The attention given to personnel deserves the best study of the engineer, whether afloat or ashore. Sympathetic scrutiny of the work of each man is possible in most power plants, since the size of the staff is ordinarily within the personal acquaintance range—an advantage not found in many great industrial establishments.

An engineer who is a real master of his profession can easily find out the lines of work in which his subordinates excel, especially in jobs requiring independent thinking, suggestions as to more economical methods, self-control in emergencies, the power of forecasting load conditions, accident prevention and other activities. In this connection even "fool" suggestions from subordinates deserve consideration. Few indeed have advanced to the point where they never offer impracticable ideas to their superiors, and the very proffering of a suggestion shows that there is something in the mind of the one making it which needs encouragement or clearing up by the chief executive of the plant. Patient explanation rather than ridicule should always be accorded suggestions from the ranks, and often, from apparently useless discussion, ideas will develop which, when worked on by several acute minds, can be turned to good account.

Recognition of latent abilities is naturally more difficult than early appreciation of the more obvious strong points of the staff. Where the "chief" has the full confidence of his subordinates, such recognition is often the result of close association. One of the best ways to bring this out is by encouraging men to occupy their spare time on shifts in congenial tasks leading toward plant betterment, toward the construction of home-made devices to save labor or to cut down waste, or in comparative analysis of operating results and conditions among different stations. In one plant built a few years ago all the wiring since installed in connection with extensions has been done by the switchboard operators, and for considerably less than the expense of outside contractors' service. Beginning in a small way, it was found that these men had talent in this direction, and the gradual extension of their work to cover these betterments followed. Some of it naturally had to be done outside regular shifts, but the men were accordingly compensated, and gained a detailed knowledge of their equipment which would have been hard to secure otherwise. The evolutionary psychology of plant operation may not have been recognized under this name in many cases, but unquestionably there is a wonderful opportunity to realize latent human powers in the administration of many stations along some such line as indicated above.

Correspondence

Emergency Gas-Engine Governing

Recently, it became necessary to remove the governor from a 105-kw. 60-cycle three-phase direct-connected gas-driven unit during a heavy load. This unit was used to carry the peak load, and it was imperative that it be kept running. It was then decided to run the unit without a governor on full load, letting the remaining units, which were also gas-driven, take care of the load variation during the peak which was fairly steady. This was accomplished as follows:

The engine, which was governed by the quantity method, using a throttle-type mixing valve, was brought to the proper speed by elevating and blocking the mixing-valve stem and switched onto the circuit. The mixing-valve stem was then adjusted until the engine carried full load, and securely fixed.

There is one hazard to this method of governing—should the load suddenly fall off the engine would overspeed and might wreck itself; therefore, the load should be carefully watched.

G. Strom.

Titusville, Penn.

Automatic Stop Valves

I was much interested in the editorial entitled "A Plea for Automatic Stop Valves" in the July 13 issue of *Power*. However, I think the plea was too mild. The installation of the automatic stop valve should not be left to the owner's discretion but should, as in the case of the safety valve, be required by law. If it is essential that a safety valve should be placed on a boiler to prevent the boiler from exploding because of excess pressure, and filling the plant with steam—to say nothing of damage to surrounding objects—why is it not just as essential that a "safety" should be placed on the steam outlet to prevent the plant being filled with steam in case of a break in a tube or steam line?

In the same issue of *Power* is a list of 255 boiler explosions during the second half of 1914, of which 64 were either tubes, headers or blowoff pipes. Where these plants contained more than one boiler it does not require much imagination to realize that an automatic stop valve might have been of some slight value.

Power-plant owners and civil authorities are slowly waking up and eventually we may see the time when it will be recognized that it is cheaper to spend a few hundred dollars on preventives than several thousand dollars on repairs. The "Titanic" was lost for the want of a $45 binocular.

There are two types of automatic stop valves—the ordinary valve, which is usually known as an automatic stop and check valve, and operates in one direction only, preventing the steam from other boilers entering the boiler on which it is placed, and the triple duty valve, which operates in either direction, shuts off the steam to the boiler on which it is placed if the pressure on that boiler falls below that of the steam line and shuts off the steam from the boiler to the steam line if the pressure in the line fails. The latter is the only valve which should be used. Using the other is only a partial preventive and is like wearing rubbers in a rainstorm but leaving the umbrella home.

W. L. Durand.

Brooklyn, N. Y.

The editorial appearing in *Power* of July 13 and the numerous articles that have been written on the subject are right to the point, and show that automatic stop valves are of importance secondary only to the safety valve; and I reaffirm the statements that I made in these columns some time ago, that they should be applied to the steam lines as well as to the boilers. At the present time many of the automatic valves in use may not be designed for this class of service, but when a demand is created for a valve that will admit of an intermittent or variable flow of steam, such as a change of load might cause, and that would close with a sudden rush of steam such as might be caused by a cylinder head bursting, some of the manufacturers making these valves will so improve theirs that they will be better applicable to this service.

There is, however, another condition with which power-plant employees in some plants have to contend, and that is lack of chance to escape from the engine- or boiler-room in case of an explosion or bursted steam pipe. In some plants the boilers are located in the second or third basement, and in case of accident it is necessary to go up two or three flights of narrow stairs to reach the street or other safe level. Again, the boilers may be so located that escape in that direction would be cut off. Such stairways, together with a slow-speed freight elevator, are in many cases the only means of egress from the plant. This condition makes it essential that automatic valves, engine stops and other safety appliances be employed.

In some basement plants the doors are either kept locked or so blocked up with boxes and waste, that in case of fire escape would be impossible.

Some months ago a certain city was shocked to learn that there had been an accident in the power plant of one of its most progressive department stores, in which four lives were lost. As is usually the case, little information that could be considered correct could be obtained at the time, but it eventually leaked out that the only outside door leading from the boiler room to an alley through which the firemen could escape was kept locked, and that to get to the street it would have been necessary for the men to pass through the engine room, storeroom, café, then up stairs to the main floor. The bursting of a steam pipe in the engine room cut off their means of escape; and as the quarters were small and as there were no automatic valves, four lives were sacrificed. Had the boiler-room door been unlocked they

could have gotten away. A new steam system was installed, but the firemen say that the door is still kept locked, and even the building inspector does not seem to realize the dangerous condition should another accident of the same nature happen. An automatic valve of the right type placed on each boiler branch would probably have saved these lives, but a simple single-seat nonreturn valve closed by the pressure in the header would have been of no help. It would have to close with the boiler pressure, and to be effective should be so constructed that it would close tight in either direction.

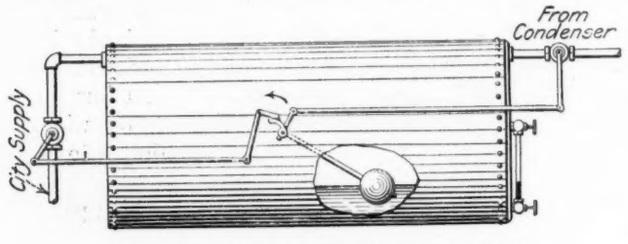
In this case the trouble occurred on a branch to one engine, and had there been a suitable automatic valve placed on each engine branch no lives would have been lost. One unit only would have been put out of commission, and in all probabilities few outside of the power plant would have known of the accident.

J. C. Hawkins.

Hyattsville, Md.

Water-Supply Regulator on Open Heater

A feed water regulator for an open heater is shown in the illustration, the regular supply being taken from the waste water of the condensers, but at times it is necessary to add to it from the city supply. The butterfly



DOUBLE CONTROL FROM ONE FLOAT

valve, shown at the left, is so connected that it becomes active only when the water in the heater is very low. This valve is actuated by the regular float, but at normal water level it is held closed by a spring.

G. H. Cunningham.

Toledo, Ohio.

Boiler Tests at Various Loads

Referring to Charles M. Rogers' article, entitled "Boiler Tests at Various Loads," in *Power* of July 20, I find that there are several points that merit attention.

I notice, first, that 0.17 and 0.18 in. of draft were required to burn 14.3 and 15 lb. of coal per sq.ft. of grate area per hour respectively, while only 0.15, 0.155 and 0.144 in. were required to burn 23.3, 23.2 and 22.2 lb. per sq.ft. per hr. From experience I would say that the draft for burning approximately 15 lb. of coal per sq.ft. was too high, accounting to some extent for the very low efficiencies obtained at these low ratings, while 0.15 in. of draft seems too low to burn 23 lb. per sq.ft. per hr. A draft of 0.35 in. in the furnace is what is usually required with overfeed stokers for this quantity of coal. Even at 45 per cent. boiler rating, with the high ratio of heating surface to stoker area, 60:1, an overall efficiency of from 60 to 65 per cent. ought to be easily obtained, provided the stokers are properly operated.

I also believe that had a separate coal analysis been made for each test, the results would have been different. In tests 4, 5 and 6 at 111, 113.8, and 111.2 per cent. rating the variations in ash and flue temperatures do not check with the efficiencies. In test 4 the flue temperature is 20 deg. lower than in test 5. The percentage of refuse dumped to dry coal fired in test 4 is 13.5 per cent., in test 5 is 14.05 per cent., and in test 6 is 13.5 per cent. Not having any ash analysis I calculate the percentage of combustible in the ash is:

$$\frac{\textit{Pounds ashes dumped} - \textit{pounds dry coal fired} \times \textit{percentage of ash in coal}}{\textit{Pounds dry coal fired} \times \textit{percentage of ash in coal}}$$

Therefore in test 4 we find 29 per cent. combustible in the ash; in test No. 5, 34.3 per cent. and in test 6, 29.4 per cent. These percentages are high for the efficiencies obtained, and seem to indicate that there might be some mistake, probably due to the use of one coal analysis for all the tests, extending over a considerable length of time. Also some CO_2 readings, taken every fifteen minutes, would have been interesting.

Furthermore, Mr. Rogers' statement that the same efficiency was obtained at 200 per cent. of rating as at 115 per cent. is not borne out in practice, as he probably would find out if he had run a 10- to 24-hr. test at this rating. Even with underfeed stokers—renowned for their high efficiency at great overloads—there is a decided loss in combined boiler and furnace efficiency at high ratings over normal load, for average installations of 50:1 to 60:1 heating surface to stoker area ratios. Mr. Rogers' statement that boilers are overloaded to obtain better efficiency is not correct, as nearly all boiler installations (except a few specially designed ones) have a lower combined efficiency under overload than at approximately builders' rating. The reason for forcing boilers is that the investment charges and the labor costs are reduced, thereby reducing the total cost of steam.

Theodore Maynz,
Engineer of Tests,
Combustion Engineering Corporation.

New York City.

Guarantees on Motor and Generator Overloads

The troubles of the purchaser of electrical machinery are materially increased by undue modesty on the part of manufacturers, who are unwilling to give their apparatus the credit it deserves. This does not refer to the verbal claims made by the sales force, but when written performance guarantees are asked there are few, if any, who will go beyond those recommended in the Standardization Rules of the American Institute of Electrical Engineers; although one manufacturer may build a much better machine than another, their guarantees will be practically identical.

In accordance with a recent revision of the standardization rules, manufacturers have ceased to give guarantees on overload performance. There can be no doubt that those selected to pass upon the rules gave careful consideration to all points and decided as seemed best for the electrical industry in general, but when one comes to purchase or operate a machine it is highly desirable to know something of its overload possibilities. Some engi-

neers claim that it is illogical to guarantee a machine to operate above its rated capacity. It would undoubtedly be so to guarantee continuous operation on overload, but such a claim appears to lose weight when the overload is for a short period; and, logical or not, most machines will be called upon to carry overloads in actual service.

A machine that has reached its maximum safe temperature on full load cannot carry a two-hour overload with safety; but the purchaser does not need one that will be able to carry the peak load continuously. A smaller generator with a rating so reduced that it will not reach the maximum safe temperature when operated at rated load can carry the peak load for the required time and still keep within the safety limit. The majority of machines built today will carry a considerable overload for short periods with safety, and some will carry more than others, but in the absence of a guarantee the purchaser is obliged to guess which of two makes will be the better. He may know that his generator will run on light load prior to the peak load and that he will therefore have a margin of safety, but he has no guarantee that the direct-current generator will commutate satisfactorily or that the alternator will maintain its voltage on the overload.

Consider the case of a motor driving a lineshaft in a factory. Under normal conditions it will operate all day at a practically uniform load which can be estimated with a fair degree of accuracy. In making this estimate one does not count on every machine connected to the shaft being operated continuously at its maximum capacity, an improbable condition. It is, however, quite likely that combinations will occur that will raise the power considerably above normal for a period of an hour or two during the day. Under such conditions the case is very similar to that of the generator and overload guarantees are equally desirable.

Motors for ordinary machine tools are sold with a rating of two hours or less. Such a rating is not made with the idea that the machine will not operate more than two hours without being allowed to cool off; it assumes that a two-hour run at rated load will produce a temperature as high as will be attained in all-day service with the widely fluctuating loads and short periods of rest inherent to machine-tool service. The majority of machine tools are subject to loads greatly exceeding the normal for periods that may vary from a few seconds to a half-hour, rarely exceeding the later, but under the present rules there is no guarantee that the motor will operate satisfactorily under such conditions. One must either equip the tool with a motor that is considerably larger than should be required or use his own judgment as to how much better the motor is than provided for in the guarantee.

If the actual temperature attained by the motor under full load were known, one might assume satisfactory commutation or regulation and obtain some idea as to its overload capacity; but here again the manufacturer's guarantee will be found to coincide with the standardization rules. These rules are based on the assumption that the insulating material will not be injuriously affected by continuous operation at a temperature within the limits recommended and that there is no particular advantage in having a machine operate at a materially lower temperature. This is probably true so long as no overload capacity is required, but a low operating temperature on full load is an indication of overload capacity. While some machines operate at temperatures very close to the limit allowed by the rules, there are others that always operate at much lower temperatures; the manufacturer's guarantee, however, is the same for all.

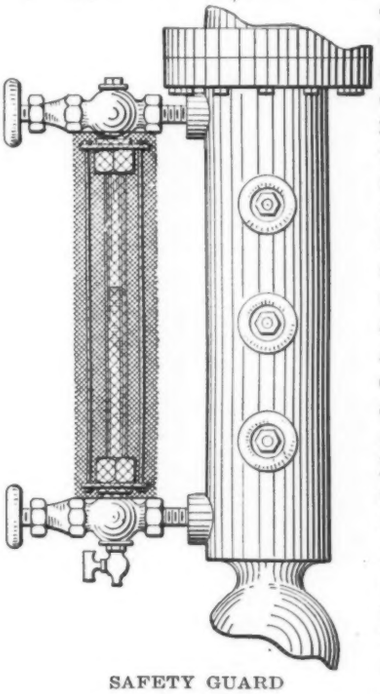
The apparent intention of the standardization rules is to fix limiting values that cannot be exceeded with safety, and to define standard methods of conducting tests, rather than to fix a uniform standard of excellence. For example, no standard values are assigned for regulation and efficiency; manufacturers' guarantees on these give an approximation of the actual performance of their apparatus. There appears also to be no reason why they should not give an approximation of the actual temperature rise and overload capacity or, if the limiting temperature is reached on full load, a guarantee to the effect that after a run on 80 per cent. load for the given period an overload of some definite amount—25 or 50 per cent.—could be carried for a specified length of time without exceeding the safe temperature limits. Such a course would be of material aid to the purchaser.

H. M. PHILLIPS.

Pittsburgh, Penn.

Guard for Gage-Glasses

The breakage of gage-glasses is one of the minor and frequent accidents of boiler operation, and it occasionally happens that the glass lets go when someone is near or looking at it. Generally, the results of such breakage merely call for the replacement of the glass, but there is the ever-present danger that small pieces of glass may be thrown with considerable force, sufficient to cause a bad cut or possibly destroy an eye. Any danger of the occurrence of such an accident has been obviated in the East Fifty-Third Street station of the Cleveland Municipal Lighting Plant by putting a guard of wire mesh around the gage-glass. This guard consists of a piece of wire netting about 9 to 12 in. wide and of a length sufficient to pass between the top and bottom connections to the gage-glass, bent to encircle the glass and the edges wired together at three or four points.



SAFETY GUARD

A guard of this kind should be readily removable, to save time. A sheet-metal edging should be used around the edges of the wire netting in order to stiffen it and prevent raveling. Possibly the "Safety First" sentiment will result in the manufacturers of water columns supplying such guards as a part of their regular equipment and selling them for a nominal price. It might make a hit, and it certainly would result in some uniformity of design.

Cleveland, Ohio. A. D. WILLIAMS.

What Is Exhaust Steam Worth?

Everard Brown, on p. 155 of *Power,* Aug. 3, discusses how the value of exhaust steam should be charged and credited as between different departments. Why not start with the live steam and charge each department with what it gets? The boiler delivers a pound of steam at, say, 165 lb. absolute and 100 deg. superheat, containing 1252 B.t.u. to, say, a noncondensing engine which uses 20 such pounds per indicated horsepower-hour. A horsepower-hour is equivalent to 2546.56 B.t.u. Then of the heat in each pound of steam, one-twentieth of 2546.56, or 127 B.t.u., is converted into work.

There are only two things that can happen to the rest of the heat—it must either be radiated or go out in the exhaust.

Suppose 4 per cent. of the original amount is radiated, $1252 \times 0.04 = 50$ B.t.u. Then there will go out in the exhaust $1252 - (127 + 50) = 1075$ B.t.u. Suppose this steam to be at 16 lb. pressure absolute; such steam contains, dry saturated, 1152 B.t.u. per lb. Having but 1075 B.t.u., it is $1152 - 1075 = 77$ B.t.u. short of the dry saturated condition. It is all at the temperature corresponding to 16 lb. pressure; so the lack is in the latent heat. The heat necessary to evaporate the full pound is 967.6 B.t.u. Then $77 \div 967.6 = 7.96$, say 8, per cent. of the steam will be water, which may be trapped out, carrying $184.4 \times 0.08 = 15$ B.t.u. with it. This may go to the boiler. Then the pound of steam would carry to the heating system or dye house $1075 - 15 = 1060$ B.t.u.

Suppose the heating system returned this to the boilers as water at 212 deg. A pound of water at this temperature contains 180 B.t.u. above 32 deg. This is only $1 - 0.08 = 0.92$ of a lb. and would carry back with it to the boilers $180 \times 0.92 = 166$ B.t.u. Crediting this, the heating system or dye house would have used $1060 - 166 = 894$ B.t.u.

The charges for the heat should be divided up somewhat in this proportion:

	B.t.u.	Per Cent.
Radiation	50	4
Engine	127	10
Heating	894	71
Boiler	{ 15 } { 166 }	15
	1252	100

The radiation might be observed and apportioned between the other services. This is to indicate the method rather than to specify amounts.

RALPH MCCARTHY.

Chelsea, Mass.

High Economy of Locomobile

In *Power* of May 11 there was published an article about the high efficiency of locomobiles, which I read with great interest.

Without doubt the locomobile is an efficient power plant taken as a whole, but the engine was inefficient before the introduction of high superheat into locomobile practice. The low coal consumption is mainly due to the elimination of radiation losses in the boiler and between the boiler and the engine and to the extensive use of feed-water heaters. An additional superheater between the high- and low-pressure cylinders of compound locomobiles and flue-gas jackets around the cylinders are means to improve the efficiency of the steam engine part, but they are both of doubtful value, and due to their mechanical complications have been abandoned by German builders. Three years ago Wolf introduced his new type of compound locomobile, built along the lines prescribed by the latest achievements in steam engineering. The engine is a compound engine with two piston valves of the Wolf type, and no resuperheater or flue-gas jacket is used. But the low-pressure cylinder is of the unaflow type, and the exhaust steam of the high-pressure cylinder is led the shortest way into the low-pressure cylinder. The passages are controlled by one piston valve. This improvement in the steam-engine part outweighs the gain which could be attained by resuperheating the steam and by the use of the flue-gas jacket, which undoubtedly renders the lubrication of the high-pressure cylinder more difficult. It also simplifies the whole power plant by relieving it of one superheater, many pipes and packings and the complicated lagging around the cylinders, which has to be made air-tight, since it forms part of the flue. Locomobiles of this type show a steam consumption of only 8.9 to 10 lb. per brake-horsepower-hour with steam of 200 lb. pressure and with 270 deg. F. superheat, running condensing. It may be added that both steam and flue-gas feed-water heaters are used for the purpose of raising the efficiency of the boiler.

Similar efficiencies are shown by the "Unaflow-Lokomobiles" of the Badenia engine works, which build the single-cylinder locomobile of the Stumpf design and the locomobiles built by Heinrich Lanz, Mannheim, Germany. The latter have compound engines with poppet valves of the Lentz type. All these builders use one superheater only, and the steam cylinders are not submerged in live steam or flue gases either, but the high efficiency is simply attained by logical design of the engine cylinder and the use of feed-water heaters so that the flue gases escape with just heat enough to generate the necessary draft.

The locomobile is a compact unit, low priced and highly efficient, and abroad has found such a wide field of application, that it is surprising how unfamiliar with its merits engineers in this country are.

WOLFGANG TURNWALD.

Syracuse, N. Y.

Uniform Size for Catalogs

With H. D. Bedinger in the issue of July 20, page 95, I also "heartily indorse the sentiment of Lewis F. Brown" in the issue of June 15, page 821, as to the desirability of a uniform size for catalogs. As file clerk of the Engineering Department of the National Tube Co., handling nearly 3000 catalogs and bulletins varying in size from 2½x3¾ in. to 11x14½ in., I have often wondered why manufacturers and dealers do not get together and adopt some uniform standard or standards.

I file the pamphlet forms in 1¾-in. expansion 9x11¾-in. paperoid pockets and to show the difference in sizes of catalogs, 54 of one size are filed in one pocket, while of another size of catalog a similar pocket holds only 12. Convenience and attractiveness could both be improved by uniformity.

DANIEL LEES.

Pittsburgh, Penn.

Inquiries of General Interest

Explosive Pressure in Gasoline Engine—In a gasoline engine, what is the approximate pressure immediately after ignition?

C. E. B.

The explosive pressure will depend on the mixture, the compression pressure and the time of ignition. Ordinarily a maximum pressure of about 250 lb. per sq.in. is obtained under the best conditions.

Packing for Gasoline Pump—What kind of packing is suitable for the piston rod of a pump used for pumping gasoline?

B. L.

A good packing may be made from lamp wick in which brown soap has been thoroughly incorporated; but as this has little elasticity, it should be placed between rings of a more elastic packing that will hold the soaped packing in place without frequent adjustment of the stuffing-box gland.

Effect of Muriatic Acid on Waterjacket of Gas Engine—Will muriatic acid when used in the waterjacket of a gas engine, for dissolving scale of sulphate of lime, have any chemical action detrimental to the material of the jacket?

J. H. G.

If used in too strong a solution, or if allowed to remain in the jacket too long, or if not thoroughly washed out after use, the acid would act on the cast iron and tend to weaken the walls of the jacket.

Conversion of Temperatures and Heat Units—How are temperatures of the centigrade scale converted into degrees of the Fahrenheit scale, and calories converted into British thermal units?

W. B. J.

Temperatures in centigrade degrees are converted into Fahrenheit by multiplying by $^9/_5$ and adding 32. Kilogram-calories multiplied by 3.968 give the equivalent British thermal units (B.t.u.), and kilogram-calories per kilogram × 1.8 give B t.u. per pound. A "small" or gram calorie is one-thousandth as large as a kilogram calorie.

Reversal of Direct-Current Dynamo—What will cause a direct-current compound-wound dynamo to reverse its direction of current under a small overload?

R. H. M.

If the series field were reversed so as to oppose the shunt field, then as the load increased there would be a weakening instead of strengthening of the excitation, and a point would be reached at which the series field would overcome the shunt field, reducing the voltage to zero. Then, as the load further increased, the voltage would build up in the opposite direction and reverse the direction of the current.

A Pound of Water Makes a Pound (Weight) of Steam—We carry 150-lb. boiler pressure, with 100 deg. of superheat. How many pounds of steam will be obtained from evaporation of a pound of water, and how many pounds will be evaporated from 100 cu.ft. of water metered at 62 deg. F.?

H. T. C.

Regardless of the quality of the steam which is generated, each pound of water evaporated will be converted into a pound (weight) of steam, and as 1 cu.ft. of water at 62 deg. F. weighs about 62.35 lb., then from 100 cu.ft. of water there would be obtained 100 × 62.35 = 6235 lb. (weight) of steam.

Power Required for Generator—If the output of a generator in watts is divided by 746 to obtain horsepower, does the result include the friction of bearings and other losses?

F. W. C.

No. The result is the equivalent horsepower output over and above friction and other losses. Hence to obtain the horsepower needed for driving the generator the output is to be divided by the percentage of efficiency of the generator for the particular load. The efficiency varies with different generators, and for the same generator it varies with different loads. Manufacturers are usually able to supply efficiency curves of their generators giving the percentages of efficiency for different loads.

Losses by Belt Transmission—In transmitting power by belts and pulleys, what is the average percentage in loss of power at each transmission from slippage, bending of belts, air resistance and journal friction?

E. V. B.

In average practice, where the tension of a belt is made no more than is necessary for transmission of the number of horsepower appropriate to its size and speed, and with the average sizes of pulleys used in practice, the losses amount to about 3 per cent. of the transmitting capacity at each transmission. The losses are substantially the same in amount when the belt may be transmitting less than such appropriate maximum.

Reading Height of Barometer—How is the height of column of a mercurial barometer adjusted and read from the scale on the instrument?

L. V. C.

A properly made mercurial barometer is provided with a well which is lined with a leather bag, and by means of an adjusting screw the bottom of the leather bag is raised or lowered, bringing the level of the mercury in the cup to the zero of the scale. The zero level is determined by a fixed ivory point. By the reflected image of the ivory point on the surface of the mercury in the well it can be known when the point just touches the surface of the mercury. This adjustment of the surface of the mercury in the well is to be made whenever a reading is to be taken.

A vernier is generally provided alongside the scale to assist in accurate observation of the height of the mercury column which is measured on the scale to the top of the meniscus.

Trouble with Screw Joints of Brass Feed Line—What may be the cause of trouble in keeping the screw joints tight in a brass feed pipe line?

H. D. E.

The screw joints of brass pipe receive no benefit of rusting to make them tighter, as in the case of iron joints, and though set up tight, the trouble may be due to the screw threads not being well matched in pitch and form of threads. Most boiler-feed lines are subjected to hammering and vibrations tending to loosen the joints, and such motion should be prevented so far as may be consistent with due allowance for expansion or contraction from changes of temperature. Another cause of loosening at the screw threads is the difference in expansion between the pipe and fitting. The pipe usually warms up quicker than the fittings, which results in distortion of the screw threads, especially if the pipe end was flattened before final setting up, as from holding or screwing up the pipe with tongs or pipe wrench placed too near the end of the pipe.

Absolute Pressures at Altitudes Above Sea Level—When used at an altitude of about 2000 ft. above sea level, and having one side of the gage open to the atmosphere, what pressure per square inch is represented by ½ in. difference of water level in a U-tube draft gage, and by 10-in. difference of level when used as a pressure gage?

H. T. C.

For ordinary purposes the pressure of the atmosphere at sea level may be assumed as equal to 14.7 lb. per sq.in., and it decreases about ½ lb. per sq.in. for every 1000 ft. of ascent. Therefore at an altitude of 2000 ft. the pressure of the atmosphere would be about

$$14.7 - \left(\frac{2000}{1000} \times 0.5\right) = 13.7 \text{ lb. per sq.in.}$$

A column of water at 62 deg. F. and 1 in. high balances a pressure of 0.03609 lb., or 0.5774 oz. per sq.in. Hence a draft gage, showing a difference of level of ½ in. of water, would represent a pressure of flue or chimney gases, with which the gage is connected, as ½ × 0.03609 = 0.01804 lb., or ½ × 0.5774 = 0.2887 oz. per sq.in. less than the pressure of the atmosphere, or an absolute pressure of about 13.7 — 0.01804 = 13.68196 lb. per sq.in. A pressure higher than the pressure of the atmosphere, which showed 10 in. difference of water level, would be due to 10 × 0.03609 = 0.3609 lb. or 10 × 0.5774 = 5.774 oz. per sq.in. greater than the pressure of the atmosphere, and the absolute pressure would be about 13.7 + 0.3609 = 14.0609 lb. per sq.in.

[Correspondents sending us inquiries should sign their communications with full names and post-office addresses. This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—Editor.]

Current-Limiting Reactors*

SYNOPSIS—The value of reactance coils, their location, the amount of reactance necessary, and the effect upon regulation.

Current-limiting reactance coils, or reactors as they are now called in the new standardization rules of the American Institute of Electrical Engineers, are coils designed to limit to a predetermined value the current that can flow when a short-circuit occurs in alternating-current circuits in which they are placed.

Limiting the current value on short-circuit to a definite figure is of benefit to the generating and distributing system in two ways—it reduces the mechanical stresses in connected apparatus due to a reduction of the short-circuit current, and minimizes the reduction in voltage due to a short-circuit. The current that can flow when a short-circuit occurs depends upon the impedance of the circuit. The mechanical stresses that are produced at such a time in the windings of connected apparatus and in switches and cables are proportional to the square of the current. If the impedance of the circuit is low and the short-circuit current high, these mechanical stresses may become tremendous, and unless everything in the circuit is substantially made and all windings securely braced, distortion and breakdown may result. By introducing reactance in the circuit the impedance is raised and the short-circuit current reduced. If by inserting reactance in the circuit the total amount of reactance is doubled, the current, when a short-circuit occurs, will be reduced to one-half and the stresses to one-fourth of their previous value.

Heavy short-circuit currents that flow in a system unprotected by reactance coils, besides creating severe mechanical shocks that may cause an interruption of the service, produce a big drop of voltage, due not only to the flow of the current through the impedance of the circuit, but also to a demagnetizing effect which it has on the generator fields. This drop of voltage affects the whole system. Reactors may be placed in the circuits in such a way that they will not only reduce the mechanical strains due to the "short," but will also practically localize it in the feeder or section of the bus where it occurs, and its effects on other feeders or bus-sections will be minimized.

LOCATION OF REACTORS

There are three places in a generating and distributing system where current-limiting reactors may be used to advantage—in the generator leads, between sections of the bus, and in the outgoing feeders. In determining where the reactors should be placed, past experiences with short-circuits will serve to show where such troubles are likely to occur in future operation. Having data of this kind, a study of the layout of the system will show where the reactors are needed.

If the generator windings show any signs of weakness and the records show that "shorts" between the generators and the busbars are not uncommon, reactors should be placed directly in the generator leads. This is the surest method of protecting a weak generator or its circuit-breakers. It is not very effective, however, in limiting the current that can flow into a short-circuit on some feeder, and it does little good in minimizing the drop of voltage at the busbars.

If a number of generators are used in parallel, a "short" in any generator or between a generator and the busbars will cause all of the generators to feed into the "short" and the busbar voltage will drop practically to zero. If such "shorts" are likely to occur, it will be desirable to sectionalize the bus and place reactors between the sections. This will limit the current that can flow between generators and have a marked effect on maintaining the voltage of the busbars when a "short" occurs.

If a large percentage of the "shorts" occur on the feeders, outside of the station, reactors placed in the feeder circuits will be effective in protecting the apparatus and maintaining service. The feeder reactor will practically localize the trouble in the circuit where it originates; the reduced short-circuit current in that one feeder will be of little importance in its effect on the generators and, therefore, on the busbar voltage; the feeder breakers will be protected and the circuit opened more safely.

One of the serious effects of a drop in busbar voltage is that all synchronous apparatus of the system will be likely to fall out of step and be shut down. Reactors placed directly in the generator leads will offer no protection against such trouble. Busbar reactors will be effective in confining the trouble to practically one section. Feeder reactors will be most effective as they will minimize the effects of a "short" on the busbar voltage.

AMOUNT OF REACTANCE

The right amount of reactance to use in protecting a system is a problem that requires careful study; it is the final step in arriving at the actual specifications for the reactors. Reactance may be compared to life insurance. The amount should be sufficient to give protection; it should not, however, be so great that it is a hardship to carry it. With no reactance no protection is given. With an unreasonably large amount of reactance the first cost and the cost of the electrical losses in the reactors form an excessive premium to pay. It seems that the right amount to use generally lies between a minimum of 2 per cent. and a maximum of 7 or 8 per cent.

In considering the amount of reactance to be placed in the leads of generators, the armature reactance of the machine and the short-circuit current it would allow if left to itself, must be considered. A high-speed turbo-generator may have from 7.5 to 10 per cent. inherent reactance at the instant of short-circuit; a slow-speed engine or waterwheel type of generator may have twice this amount. Five per cent. reactance added externally to the turbo-generator with its 7.5 reactance will reduce the current at short-circuit to 60 per cent. of what it would be without protection, and the mechanical stresses would be reduced to 36 per cent. The same amount of reactance added to the slow-speed generator with its 15 per cent. inherent reactance will reduce the short-circuit current to 75 per cent. of what it would be without external reactance, and the mechanical stresses would be reduced to 56 per cent. To get a certain amount of protection for a generator, then, its inherent characteristics play an important part in fixing the right amount of external reactance.

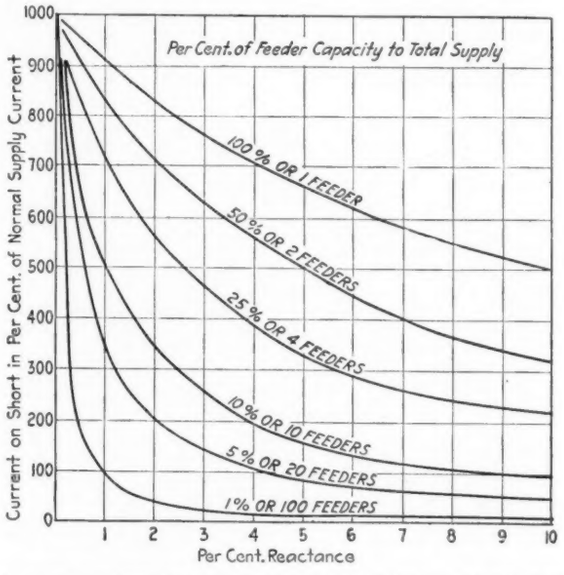


FIG. 1. EFFECT OF FEEDER REACTANCE IN LIMITING SHORT-CIRCUIT CURRENT IN FEEDERS; GENERATOR REACTANCE = 10 PER CENT.

The problem of how much reactance should be placed between bus sections is more complicated; it can be solved only by a careful study of the layout of the system. In general, a compromise must be arrived at between a large amount of reactance, which would have the maximum effect in protecting the system and maintaining busbar voltage, and a small amount of reactance, which would allow more nearly the equal loading of generators in parallel under normal conditions.

The amount of reactance to be placed in feeders will depend upon the size of the feeder, the relation its capacity bears to the generator capacity and the breaking capacity of the circuit-breakers.

*Abstract of paper prepared by W. H. Dann and H. H. Rudd, of the Westinghouse Electric & Manufacturing Co., for the convention of the Ohio Society of Mechanical, Electrical and Steam Engineers at Toledo, June 17 and 18.

Consider a station having a generating capacity of 10,000 kv.-a., the generators having an inherent reactance of 10 per cent. If the output is distributed over ten 1000-kv.-a. feeders unprotected by reactances, a "short" on any feeder will draw 100,000-kv.a. from the generators; which is one hundred times the normal capacity of the feeders. The reactance of the generators is therefore equivalent to 1 per cent. reactance in the feeders. If 3 per cent. extra reactance is placed in each feeder, the conditions will be equivalent to a total of 4 per cent.; the short-circuit current will then be limited to 25 times the normal current of the feeder, or 25,000 kv.-a. on the generators, and the mechanical stresses in the system will be reduced to only 6.25 per cent. of their value without the 3 per cent. reactances.

If the 10,000-kv.-a. generator capacity is distributed in two 5000-kv.-a. feeders unprotected by reactors, the short-circuit output of 100,000 kv.-a. represents 20 times the normal capacity of the feeder, and the generator reactance is equivalent to 5 per cent. protecting reactance in the feeder. This current is less in proportion to the normal current than in the case of the 1000-kv.-a. feeders with their 3-per cent. reactances. As far as protection to the feeder itself is concerned, very little extra reactance, if any, is required; to limit the generator current to the same figure as in the previous case and thereby keep the busbar voltage up to the same degree would require an extra feeder reactance of 15 per cent. To get the equivalent protection for the busbar voltage the percentage reactance for each feeder may therefore be reduced as the number of feeders is increased.

One thing to be considered in installing current-limiting reactors is that increasing the reactance in the system results

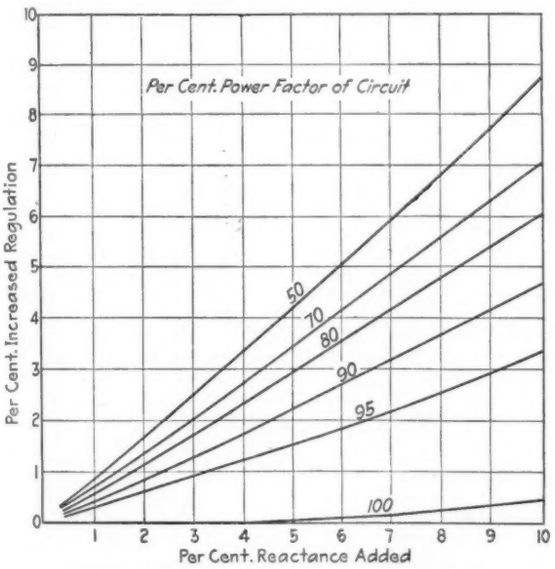


FIG. 2. INCREASE IN REGULATION FOR CIRCUITS OF VARIOUS POWER FACTORS WHEN REACTANCE IS ADDED

in a slightly lower power factor and slightly poorer regulation. The effect on the regulation is more marked if the operating power factor is much below unity. However, the amount by which the voltage of the system is lowered is not seriously large; it can be compensated for by increasing the voltage of the generators. Fig. 2 shows the amount by which the voltage of the system is lowered by the addition of reactance, for several different power-factor conditions. For example, if 5 per cent. reactances are added in all of the feeders of a station and the operating power factor is 80 per cent., the generators should be excited to give 3 per cent. more voltage, to maintain the busbar voltage obtained without the reactors.

RATING OF REACTORS

The characteristics of a current-limiting reactor are definitely fixed by a statement of: (a) The reactance expressed as a percentage of the normal voltage of the circuit; (b) the characteristics of the circuit in which it is to be placed—normal kv.-a., normal voltage between wires, phase of the circuit and frequency; (c) the temperature at which it operates under normal conditions.

The normal current for the coil will be the normal value of the current of the circuit in which it is placed. For a single- or two-phase circuit this current will equal the normal kv.-a. per phase divided by the normal line voltage; for a three-phase circuit it will equal the total normal three-phase kv.-a. divided by 1.73 times the voltage between wires.

The normal voltage drop across the coil will be developed when normal current at normal frequency is flowing through the coil. This voltage drop will be the given percentage of the normal voltage between wires in a single-phase or two-phase circuit; or the given percentage of the voltage from line to neutral (voltage between wires ÷ 1.73) in a three-phase circuit.

Current-limiting reactors must of necessity carry the maximum overload currents that the circuit is called upon to carry, and with a reasonable ultimate temperature. Reactors of this kind, however, can safely operate at a higher temperature than would be safe for generators and transformers, because of the open and well-ventilated construction which is possible, and for the reason that materials which will not be injured by such temperatures can be used. Since a higher operating temperature is reasonable and is an important factor in reducing the size and cost of such coils, a temperature rise of 75 deg. C. (167 deg.F.) under normal conditions represents common practice.

Five per cent. reactances for a 3000-kv.-a., 11,000-volt, three-phase, 60-cycle feeder would be designed to carry 157 amp. and to have a voltage drop of 318 volts at 60 cycles when that current is flowing. The normal rating of each of the three reactors would be 50 kv.-a. (318x157, or 5 per cent. of 1000 kv.-a.) at 157 amp., 318 volts, 60 cycles.

Hot-Water Heating System at Grand Central Terminal*

By W. G. Carlton†

The Grand Central Terminal in New York City covers the territory between Fiftieth St. on the north and Forty-second St. on the south, extending from Lexington Ave. westerly an average distance of about 750 ft. and reaching through to Madison Ave. for four blocks. Under about two-thirds of this space there are two levels of railroad tracks and a single level under the rest. At present there are ten buildings varying from 6 to 28 stories in height and having, in the aggregate, about 50,000,000 cu.ft. Some of these buildings are for railroad purposes and the others for general use. There is one large hotel, one club, one exhibition building, a railroad Y. M. C. A., and others for general office purposes. Steelwork has been installed heavy enough so that more buildings can be erected over tracks as conditions warrant.

The heating of practically all these buildings is by hot water circulating from a plant at Fiftieth St., near the northeast corner of the Terminal. Pumps and heaters for the hot-water system are on the first floor of the plant at approximately street level and 51 ft. above the New York Central datum. The greater part of the distributing pipe is in pipe galleries at one side of or below the railroad tracks, the lowest pipe elevation being 7 ft. below datum. The heating system is divided with respect to plant elevation in three levels, as follows: Low pressure, 8 to 170 ft.; intermediate pressure, 170 to 288 ft.; high pressure, 288 to 395 ft. The heaters are of the surface-condenser type, each containing 1871 three-quarter-inch tubes, 15 ft. long. There are two heaters on the low-pressure and one each on the intermediate- and high-pressure systems.

A considerable part of the steam for these heaters is supplied from the exhaust of three 500-kw. turbo-generators, these machines being part of the Terminal light and power equipment. Live steam is used if necessary. Rotary converters furnish the balance of the electric power for the Terminal, and the converter capacity is sufficient so that the turbines are run only when the exhaust steam can be used for heating purposes. The rotary converters receive power from a power house seven miles distant, which furnishes power for the electric operation of trains.

The circulating pumps are of the centrifugal type, 14-inch single-stage, and are direct-connected to 175-hp. electric motors with a speed variation from 500 to 1000 r.p.m. The capacity of one pump against a head of 100 ft. is approximately 5000 gal. per min. Under ordinary operating conditions the combined efficiency of pump and motor is about 60 per cent. Four pumps are provided on the low-pressure system, two each on the intermediate and high. Under maximum-load conditions, to the present time, three motors have been sufficient for the low-pressure load and one each on the intermediate- and high-pressure systems. The main distribut-

*From a paper read June 3 before the National District Heating Association, Chicago.

†Superintendent of power, Grand Central Terminal, New York City.

ing lines are of 18-in. steel pipe with joints of the Van Stone type. Expansion is taken care of in some cases by loops and in others by expansion joints. Practically all of the pipes are installed in pipe galleries, and are accessible for any necessary repairs.

Venturi meters are provided at the service plant on each of the three main supply lines and at each building where service is given. In buildings heated from more than one pressure system, there is a meter for each service. Recording thermometers are installed with each meter, one each on supply and return. Some experiments have been made with a differential type of thermometer, so that only one instrument would be needed, but as yet this type has not been satisfactory. The total of the readings obtained from the 15 venturi meters on the building services tallies quite closely with the total from the three master meters at the service plant.

The heat furnished a given building is computed from the amount of water and the difference in the temperature between the supply and return of water. Rates are based on a unit of 1,000,000 B.t.u., this being approximately equal to 1000 lb. of steam. They are on a sliding-scale basis and compare in a general way with rates in effect for steam heat supplied by New York public-service companies, which have fixed rates per thousand pounds of water evaporated.

The amount of heat furnished can be regulated by varying either the amount of water circulated or the temperature of the water. The latter method is used during the colder part of the winter for most of the regulation. The engineer has a table showing the temperature of water to carry for a given outdoor temperature. This table is followed, except in case of high winds, when water is carried at a higher temperature than given by the schedule. The maximum drop in temperature between supply and return for the coldest weather is about 25 deg. The mean drop for the colder months is 16 deg. The maximum amount of water circulated is 6000 gal. per min. on the low-pressure system, 2300 gal. on the intermediate- and 1200 gal. on the high-pressure system. There are 600,000 sq.ft. of heating surface in the buildings heated. The total heat delivered to buildings during the heating season will not be far from 250,000 units of 1,000,000 B.t.u. each.

The Water Softener in Feed-Water Treatment*

SYNOPSIS—The water softening equipment in the capitol power plant of Madison, Wis. The chemicals used and the results obtained.

One important factor common to nearly every form of industry is the need of water. In a thousand different ways water is a necessity, and while substitutes are found for nearly all other raw materials, none is known for this. Only one use of water will be considered in this paper, that is, for the production of steam for power and heating.

It may be well first to investigate the source of water and its impurities. The vapor formed through evaporation by the sun from the sea and land surfaces, when condensed, produces rain, which is the natural source of fresh water. While falling through the air the rain absorbs some of the atmospheric constituents, one of them being carbonic-acid gas, which becomes important later as the agent that enables the water to dissolve and hold in solution certain salts of lime and magnesia, the chief hardening and scale-forming elements in a boiler water. The falling rain may also pick up soot, dust, etc., but these are not for present consideration. After reaching the earth water either sinks into the ground or flows over its surface into rivers and lakes. In either case it dissolves a portion of various elements with which it comes in contact. Therefore, all water, from whatever natural source, contains some impurities, the quantity and nature of which depend upon the formation of earth over or through which it has passed. When introduced into a boiler some of these impurities are precipitated or crystallized out, either by heat or because the water becomes over-saturated, owing to evaporation. These impurities take the form of sludge, crusts or scale, which may be powdery and porous or dense and hard, according to the nature of the salts deposited.

As the deposit accumulates in a boiler, in the course of time its removal becomes imperative to save the metal of the boiler from overheating. The amount in a 400-hp. boiler evaporating daily 50,000 gal. of water containing 20 grains of sediment per gal. would be nearly 1000 lb. of dirt after a run of one week, so it is apparent that the boiler would require cleaning. The work of cleaning a boiler after it has become badly scaled is not only time-consuming and expensive, but the boiler tubes or sheets are often injured by the hammers, picks and chisels used.

ORIGIN OF CHEMICAL TREATMENT

For many years engineers have realized the desirability and economy of some method of treating water to either precipitate the scale-forming elements outside the boiler or to change their chemical composition so that when deposited inside the boiler they would form a soft sludge, or mud, which would not adhere to the boiler surfaces and therefore could be easily washed out. Both methods are in use at present. The external method was first devised about 60 years ago by Doctor Clark, an English scientist, who introduced the method of treating water with lime to remove the carbonates of lime and magnesia and the carbonic acid. Following this, another Englishman, Doctor Porter, used soda ash to remove the sulphates of lime and magnesia. These methods were subsequently combined into the Porter-Clark process, which is in general use today. Many other treatments have been put on the market, but the principle is the same in nearly all, the only difference being in the chemicals utilized to cause precipitation. As to temperature, the external method may be divided into two types—the cold treatment and the hot treatment; the difference being that in the latter the use of lime is dispensed with, as heating the water causes a precipitation of the greater part of the salts which are acted upon by the lime in a cold process. The conditions in the plant determine which is preferable.

In either case an analysis is essential, as waters from two different sources are not of the same composition and the character of any water is liable to change with changes in temperature, rainfall, etc. Naturally, artesian water is more stable in composition, but that from rivers and lakes changes frequently.

The troublesome salts are carbonates and sulphates of lime and magnesia, and the treatment of boiler-feed water in a softener consists mainly in getting rid, as completely as possible, of these salts.

An analysis of Lake Monona water used at the Capitol station is as follows:

Constituent	Grains per U. S. Gal.
Volatile and organic	6.76
Silica	0.05
Calcium sulphate	2.04
Calcium carbonate	4.69
Magnesium chloride	0.69
Magnesium carbonate	3.64
Iron carbonate (ferrous)	0.15
Sodium carbonate	2.38
Total solids	20.40

Volatile and Organic Matter—Matter held either in solution or in suspension. Of animal or vegetable origin. Causes foaming and corrosion in boilers. Can be overcome by the use of filters, coagulants, addition of lime and soda.

Silica—Quartz or sand. Of little importance, as but small quantities are usually found in most waters. Easily precipitated by heating at atmospheric pressure.

Sulphate of Lime—Known as plaster of paris or gypsum. A very poor conductor of heat. About the worst thing in a boiler-feed water. Forms hard scale. Can be removed from water by the addition of carbonate of soda (soda ash).

Carbonate of Lime—Known as limestone, marble, chalk. Forms soft scale or mud in boilers except when sulphate of lime is present, when it is cemented into a hard scale. Can be precipitated by heating feed water or by the addition of hydrated lime.

Carbonate of Magnesium—Known as magnesia. A very poor conductor of heat. Forms scale. Held in solution by carbonic-acid gas the same as carbonate of lime. Treatment the same as for lime carbonate.

Chloride of Magnesium—Corrodes boilers. Very soluble in water. At boiler pressures or temperatures it decomposes, the magnesia being precipitated, while the chloride combines

*A paper on "The Water Softener in the Treatment of Feed Water, with Results Obtained at the Capitol Power and Heating Plant, Madison, Wis.," read before the Engineering Service Club of the State Capital Building, Madison, Wis. By H. R. Dorman.

with the steam to form hydrochloric acid. Treated by the addition of soda ash.

Iron Carbonate—Present as bicarbonate in solution, being held dissolved by carbonic acid. Readily precipitated by means of lime.

Sodium Carbonate—Known as washing soda, soda ash, etc. If in large quantities may cause foaming. May be precipitated by barium carbonate, a byproduct of sugar refineries.

To understand comprehensively the chemical changes produced in the water by the addition of lime and soda ash, it is necessary to define what softened water is. Water such as that described (from Lake Monona) is called hard water because it is difficult to produce a soap lather or suds with it. This is one of the best-known indications of a scale-forming water.

Hardness of water is ordinarily classed as either temporary or permanent. The degree of hardness is usually based upon the number of grains of solids per gallon, and waters may be classed accordingly as follows: 1 to 10 grains per gallon, soft water; 10 to 20, moderately hard; 25 and above, very hard.

Collet, in his book, "Water Softening and Purification," opposes this statement by saying that the hardness of a water as determined by the soap test does not necessarily mean that so many grains of solids are in the water, but that so many cubic centimeters of soap are destroyed in producing a lather; that the grains of solids in the water may be more or less than indicated by the cubic centimeters of soap used. However, in the operation of a softener and testing of the treated water, it is necessary to have some easily understood standard of comparison, and probably that of basing one grain of solids per gallon as equivalent to one cubic centimeter of soap destroyed is accurate enough for all practical purposes.

Temporarily hard waters are those containing carbonates of lime and magnesium held in solution by an excess of carbonic acid in the water. These carbonates can be precipitated by boiling at atmospheric pressure or by the addition of hydrated lime, when, if there are no other scale-forming ingredients present, the water becomes soft.

Permanently hard waters are those containing mainly the sulphates of lime and magnesia, which are only precipitated at the high temperatures found in a boiler at working pressure or by concentration or by a combination of high temperature and a reaction with the steam, as in the case of magnesium chloride.

CHEMICAL REACTIONS INVOLVED

Consequently, the process of water softening is one in which the water is freed from the before-mentioned salts and is accomplished by chemical precipitation of the scale-forming ingredients. The salts, calcium and magnesium carbonates, are held in solution in the water by an excess of carbonic acid, and on the addition of hydrated lime in the softener the excess carbonic acid combines with this lime, forming calcium carbonate. As there is now no excess of carbonic acid to hold the salt in solution, the carbonate of lime is precipitated. Magnesium carbonate requires the addition of a somewhat greater quantity of lime before precipitation occurs than does the calcium carbonate. The reaction for these carbonates is as follows: For calcium carbonate—Calcium carbonate plus carbonic acid plus hydrated lime equals calcium carbonate; for carbonate of magnesia—Carbonate of magnesia plus carbonic acid plus hydrated lime equals carbonate of magnesia plus carbonate of calcium. This being still soluble, more lime must be added. Carbonate of magnesia plus hydrated lime equals hydrate of magnesia.

The salts causing permanent hardness are treated in the water softener by the addition of soda ash; the reaction, as commonly understood, being the conversion of the sulphates to carbonates by the soda ash, and the precipitation of the carbonates due to the excess carbonic acid being eliminated from the water. Collet states: "To remove sulphate of lime it must be converted into carbonate of lime. This is done by means of carbonate of soda (soda ash), the soda combining with the sulphuric acid of the sulphate of lime, forming sulphate of soda, which is soluble, neutral and inert in boilers or with soap; while the carbonic acid combines with the lime and forms a precipitate of carbonate of lime." Any chlorides or nitrates in the water are likewise precipitated by the soda ash.

An interesting and beneficial result of the lime and soda-ash process of treatment lies in the fact that the lime added does not remain in the water, but after combining with the excess carbonic-acid gas is itself transformed into the insoluble calcium carbonate and precipitated. The soda ash added, while not precipitated as the lime, is changed to sulphate of soda, which is a neutral salt, and while it may concentrate in the boiler because of evaporation of the water, it will not form scale. Foaming may perhaps result if the concentration becomes very great, although Christie, in his "Boiler Waters," states that experiments to determine the quantity of sodium sulphate necessary to cause foaming showed that from 250 to 1000 grains per gallon, depending on the type of boiler, could be added without signs of foaming.

The theoretically correct quantities of lime and soda ash to be added to the water are determined, after an analysis of the water has been made, by means of a table issued by the L. M. Booth Co. From this table the proper quantity of each reagent—lime and soda ash—required per 1000 gal. for each grain per gallon of the various constituents of the water may be computed by the following rule:

Multiply the quantity of each component, as determined by chemical analysis in grains per U. S. gallon of the water to be treated, by the decimal set opposite; the result will be the quantity of lime or soda ash required per 1000 gal. of water treated.

Component	Lime 90 per Cent. Cal. Oxide	Soda Ash 58 per Cent. Sodium Oxide
Calcium carbonate	0.098	
Calcium sulphate		0.124
Calcium chloride		0.151
Calcium nitrate		0.104
Magnesium carbonate	0.234	
Magnesium sulphate	0.079	0.141
Magnesium chloride	0.103	0.177
Magnesium nitrate	0.067	0.115
Ferrous carbonate	0.169	
Ferous sulphate	0.070	0.110
Ferric sulphate	0.074	0.126
Aluminum sulphate	0.087	0.147
Free sulphuric acid	0.100	0.171
Sodium carbonate	0.093	
Free carbon dioxide	0.223	
Hydrogen sulphide	0.288	

With most waters, after the theoretically correct quantities of lime and soda ash have been calculated, it will be necessary to use a cut-and-try method of increasing or reducing these quantities until a satisfactory degree of softness

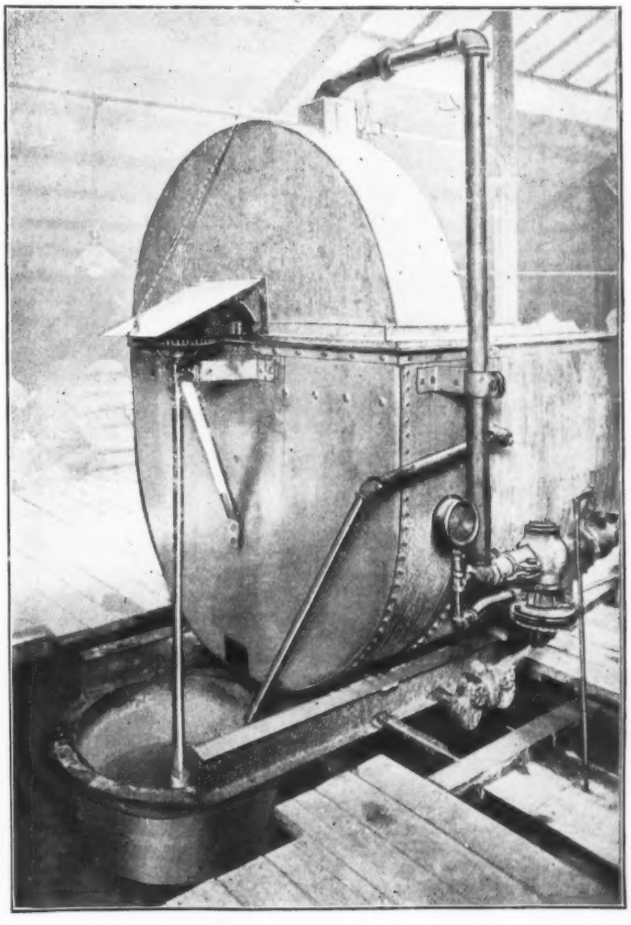


FIG. 1. END VIEW OF CHEMICAL MIXING TANK

is obtained. With the Lake Monona water treated in this plant the variation in hardness is very marked, a difference of from 12 to 14 points having been observed during the year as the seasons changed. This has compelled a correspondingly frequent changing of the quantities of reagents used. In contrast is the treatment of water at the State Hospital at Mendota, Wis., where the supply is from a driven well and the hardness is very nearly constant throughout the year.

The introduction and increased use of water softeners in this country is due, in a great measure, to the railroads, and their use has resulted in an increased mileage from each locomotive unit between layups in the repair shops. It is stated that over three-quarters of all boiler repairs to locomotives were due in some manner to bad water.

While the first cost of installing a water-softening system may seem prohibitive in a small plant, it should be balanced by the consideration that the life of the boilers may be doubled, the efficiency increased, cleaning and repair bills reduced, and in line with the "Safety-First" movement at present so widely exploited, the reduction in hazard from boiler failures with attendant loss of life and property would certainly seem to justify an investment of even 50 per cent. of the boiler cost in some system of providing soft water.

The softener in use at the Capitol Power & Heating Plant is a top-operated Northern Water Softener, of the cold-process, continuous type, with a capacity of 96,000 gal. per 24 hours.

All water for station use is taken from Lake Monona through a 24-in. line about 1800 ft. long, extending about 500 ft. into the lake, and the normal submergence of the intake opening is 8 ft., to avoid drawing surface water or silt from the lake bed into the line. The water flows by gravity through this line to an intake well 20 ft. in diameter by 24 ft. deep, just outside the boiler house. From this well it is pumped by two 12x8x12-in. duplex steam pumps through a

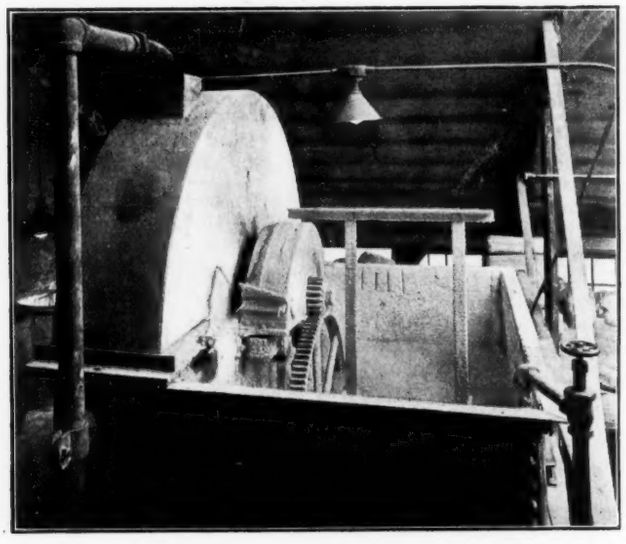


FIG. 2. SIDE VIEW OF MIXER, SHOWING PADDLES

reducing valve (which maintains a pressure of 7½ lb.) directly into the operating mechanism, Fig. 1 (which is a small waterwheel for stirring and feeding the chemicals from the chemical tank, and also mixing the water and chemicals in the downtake of the softener), thence into the tank. This chemical tank, another view of which is shown in Fig. 2, is above the main tank and has a capacity of 390 gal. For convenience in measurement and computation the tank is divided into 13 divisions of equal volume. The ratio of the mixture fed from the chemical tank to the total water passing over the wheel is approximately one ounce to the gallon. This is fed to the raw water by means of an endless bucket elevator discharging into a cup, thence through an orifice of known area to the downtake. A constant head is maintained above the orifice in the cup, so that the discharge will be uniform at all times. After mixing, the water flows to the bottom of the downtake and up on the outside to the discharge opening near the top of the softener. Precipitation occurs during this period, but any foreign matter that has not settled out is caught by an excelsior filter just below the water line. After treatment in the softener the water passes to a makeup or storage tank, then to the open heater, then by the boiler-feed pumps to the boilers.

During the heating season the return water from the heating system at the Capitol building supplies the boilers. This return is a mixture of condensed steam and cooling water and shows about one-half the hardness of the lake water. Hence there is a considerable saving on the chemicals used, and likewise in fuel, due to the higher temperature of the returns over that of the lake water.

The chemical tank is charged once or twice in 24 hr., depending upon the quantity of water used. The quantities of lime and soda ash necessary to recharge are determined by measuring the chemical mixture remaining in the tank. Tests of both the treated and the raw water are made regularly every morning and oftener if conditions seem to demand it. These are simple and quickly performed with the aid of a small testing cabinet furnished with the softener. The operation, as described by Collet in "Water Softening and Purification," is as follows:

When water is undergoing treatment it should be tested every day, and perhaps oftener. The usual slow and complicated method of analysis is not practicable, and a few special tests have been devised which, without evaporation, weighing or special manipulation, will show in a few minutes the hardness, causticity and alkalinity of the water being treated. This method, known as the volumetric method, consists in adding exactly measured volumes of reagents of known strength to exactly measured volumes of water, an indication being given either by change of color or by other means when the exact quantity of the reagent required has been added. The change in color is obtained by the addition in minute quantities of certain dyes such as litmus, cochineal, phenolphthalein, methyl orange. In treating hard water two principal tests are used—with soap, and with acid.

The Soap Test—Lime or magnesium salts in solution destroy or neutralize soap in quantity roughly proportionate to the amount of these salts held in solution. That is, they combine with the fatty acids in the soap and form an insoluble earthy soap that cannot make a real lather, though it may form a curd or scum on top of the water.

The soap test is one that, without being absolutely accurate, is the most generally useful method devised for testing the hardness of water, its principal failure being that it does not discriminate between the hardness due to lime and that due to magnesia to any useful extent. There is a slight difference in the action of the soap in water containing lime and water where magnesia is present; with lime the reaction seems to take place very quickly, while with magnesia present the reaction is slower.

Water to be tested should be as fresh as possible, or tested in the same condition in which it will be used. Vegetable matter in the water will cause a froth that interferes slightly with the soap test. If free carbonic acid is present in the water in any quantity it will tend to increase the hardness.

When properly treated the water should show alkalinity, hardness and causticity in approximate relation of 6-5-4. If too much lime is used the hardness will fall and the causticity rise, while if not enough lime is added the reverse will occur. The hardness should not be in excess of two points less than the alkalinity.

When too great a quantity of soda ash is added, the hardness is lowered and the alkalinity raised. If not enough soda, the hardness is raised and the alkalinity lowered.

The Acid Test (Alkalinity and Causticity)—Alkalinity is a general term used for waters containing compounds with the power of neutralizing acids. Causticity, as used in water treatment, is a term used to indicate the presence of an excess of lime added during treatment. Though such presence would also indicate alkalinity, the term is generally used to apply to those hydrates the presence of which is indicated by phenolphthalein.

The temporary hardness of a water (due to carbonates) may be easily ascertained by testing its alkalinity with acid. The carbonates of lime and magnesia are weak alkalies and their quantity can be tested by neutralizing with a standard weak solution of sulphuric acid. Either phenol or methyl orange may be used as indicators. Methyl orange is of a pale lemon-yellow color in alkaline liquids and retains its color upon addition of the sulphuric acid till the point is reached when all the carbonates of lime and magnesia have been changed to sulphates. The color then changes to a weak orange, and any further addition of the acid changes it to pink or red.

Phenolphthalein has a purple-pink color in the water if carbonates of lime and magnesia are present, but becomes colorless as the sulphuric acid is added which changes the carbonates to sulphates.

The full alkaline strength of a water due to the carbonates of lime and magnesia is indicated when using the methyl orange; the phenol shows only the alkalinity not concealed by carbonic acid.

For four years before the installation of the water softener at the Capitol plant, different makes of boiler compounds were used. During this time it was customary to cut out and clean a boiler after one week's run. In nearly every instance it was found necessary to use the turbine tube cleaner to dislodge the hard scale formation, besides chipping and pounding loose the scale accumulated on the tube sheets. Since the water softener has been in commission the boilers are operated four, five and six weeks at a time, and the work and cost of cleaning and repairing has been materially reduced.

The data taken from the station records for the past year and a computation made from the average of bids received from different concerns for treatment with boiler compounds show the cost of the former to be only about one-half that of the latter. The results are not supposed to apply to any other plant, as conditions might be entirely different, but the known data of operating conditions observed in this station are decidedly favorable to treatment by an external method.

Influence of Altitude on Boilers

In the "Journal of Engineering," published by the University of Colorado, J. D. Skinner presents a short article in which it is shown how altitude should affect the size of the air and gas passages in steam boilers. He contends that one of the important causes of imperfect combustion in boiler furnaces,

with its resultant loss in economy and accompaniment of smoking stack, is a failure both by the manufacturer of the boiler and the designer of its setting to take into consideration the effect of altitude on the volume of air required for completely burning the fuel. By means of some simple mathematics he shows that the air in Denver at 32 deg. F. is only 82½ per cent. as dense as at sea level with the same temperature. The normal barometric column at the United States weather office in the Boston Building in Denver, which office has an altitude above mean sea level of 5272 ft., is 24.708 in. of mercury at 32 deg. F. This corresponds to a pressure of 12.13 lb. per sq.in. At this level a cubic foot of air at 32 deg. F. weighs 0.06662 lb. and at sea level 0.08074 lb.

The complete combustion of one pound of the same kind of coal requires a definite rate of oxygen the world over, or, as the proportion of oxygen per lb. of air is invariable, a definite rate of air. To get one pound of air at sea level and 32 deg. F. it is necessary to use 12.384 cu.ft., and for the same weight and temperature 15.009 cu.ft. at Denver; that is, 15.009 — 12.384 =2.625 cu.ft. more at the latter place. Hence it is necessary to use 2.625 ÷ 12.384 = 21.2 per cent. more air at 32 deg. F. by volume at Denver than at sea level to insure the perfect combustion of one pound of the same kind of coal.

If the air spaces in the grate and the cross-sections of the tubes and stack be increased, the extra volume of air necessary in Denver may easily be secured. However, if these passages cannot be changed, it may be possible by increasing the height of the stack to augment the draft pressure, and hence the velocity of the air passing through the grate, so that the desired end may be obtained. The lower humidity of the air at Denver, which is often but a quarter of that at sea level, will slightly affect the results here given.

Landslide Wrecks Power Plant

On Aug. 3, about 6 a.m., the power plant of the Knickerbocker Portland Cement Co., located at Hudson, N. Y., was wrecked in an unusual manner—by the slipping and subsiding of the earth on which it was built The plant was located on a terrace of "brick clay" about 50 ft. thick and a substratum of shale which had become a semifluid mass at the water level of the creek near by. The combined weight of the buildings and about 50,000 cu.yd. of crushed stone piled in the stock yard overloaded the ground and caused it to shift sidewise and settle from 15 to 25 ft. below its original level.

In the fall of 1914 a small slide occurred at the power house, back of the building and between it and the creek at a cinder fill. After the slide this was protected by a group of wooden piles driven to a depth of 40 ft. No further disturbance was felt until last week.

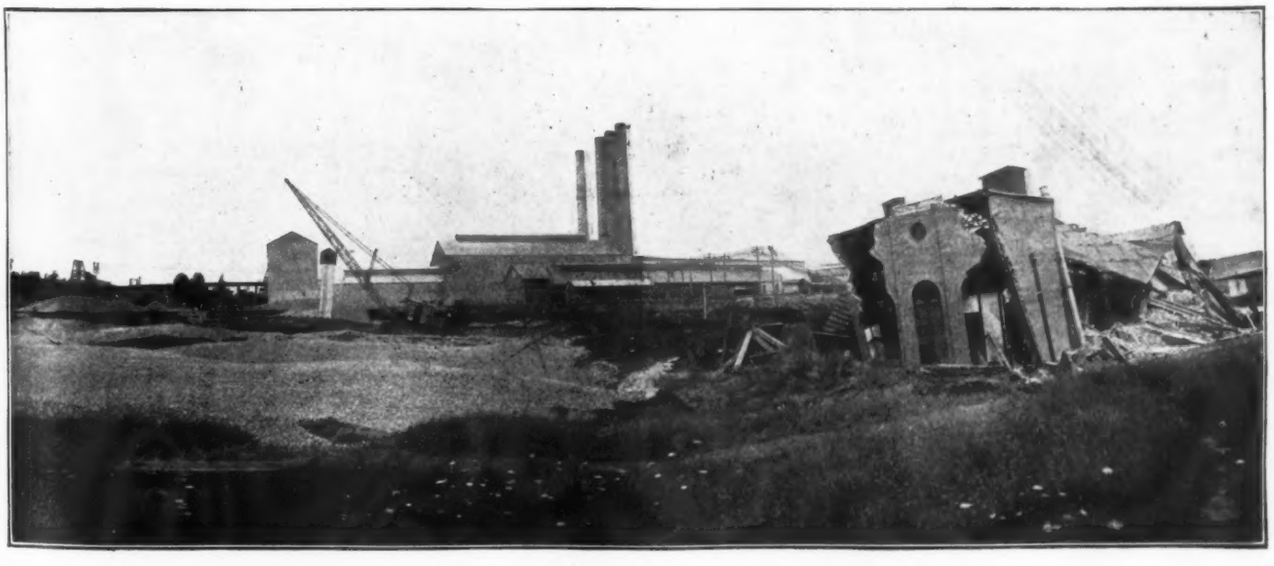
The greatest damage was caused at the power house, not only because of the value of the building and equipment, but also because the entire cement plant depended upon it for power. This building had concrete foundations and a brick superstructure and contained six 400-hp. Heine water-tube boilers, which supplied steam to two 2000-kw. Curtis turbo-generators. Alongside the building and between it and the stone pile was a timber coal trestle. The subsidence of the stockpile apparently caused the trestle and the power house to collapse, as shown. The boilers did not burst, but escaping steam from broken pipes was probably the chief cause of the death of five men and the serious injury of four others.

About 60 ft. to the right of the turbine room was located the reinforced-concrete condensing-water intake house. This settled at one end, but was otherwise undamaged. A reinforced-concrete chimney, 175 ft. high and about 10 ft. in diameter, located behind the power house, appears to have slid, base and all intact, from its original position to the creek, about 75 ft., before falling over in the direction of its motion and flattened under the impact of its fall.

The 30,000 to 40,000 tons of trap rock in the huge pile which sank formed a part of the winter supply for the mills. It was intended that this supply should ultimately exceed 100,000 tons. The rock was transported from the quarry to the crusher house, a distance of less than half a mile, by cars, which entered the crusher building on the trestle.

An underground belt conveyor carried the crushed rock from the crusher house to a reinforced-concrete elevator, 60 ft. high, located in the middle of the storage area. There it was lifted to a chute and dumped into the pile, to be rehandled to any point in the storage area by a 2-yd. 65-ft. radius electric crane running on a circular track 160 ft. in diameter. The arc of the crane track which lay within the zone of subsidence sank with the crane, but the latter was undamaged. The elevator settled 30 ft. and swung far out of plumb, but does not show other damage.

While plans for rebuilding the power plant and the other damaged structures are necessarily unsettled, arrangements are under way tending toward the resumption of business at the earliest possible date. The power station cannot, of course, be replaced for several months, and it is not known how much of the machinery will be found serviceable. In the meantime a certain amount of electric power will be bought from the Albany Southern R.R. Co. Myron Hammond, the superintendent, estimates the damage at $300,000.



GENERAL VIEW OF WORKS, WITH POWER HOUSE IN THE FOREGROUND

Rochester Convention of U. C. C. of E.

The thirteenth annual convention of the Universal Craftsmen Council of Engineers was held at Rochester, N. Y., during the week commencing Aug. 3.

There were present more than one hundred delegates, representing one hundred and sixty votes. The business sessions of the delegates were held in the Powers Hotel, and in the large banquet hall of the same building was the mechanical exhibit of power-plant equipment. The exhibit hall was formally opened Monday evening, and remained open throughout the week. The preliminary exercises of the convention took place on Tuesday morning in the Common Council chamber at the City Hall. Grand Chaplain P. H. Early gave the invocation, after which Mayor Hiram H. Edgerton welcomed

the delegates and guests to Rochester. Charles F. Siegrist, grand assistant chief, responded to the mayor. Chairman F. E. Rogers then introduced State Senator John B. Mullan, past commander of the Grand Commandery of Knights Templar of New York State. Mr. Mullan spoke eloquently on fraternalism. Secretary Edgar F. Edwards, of the Rochester Industrial Exposition Association, and a member of the convention committee of the Chamber of Commerce, dilated on the beauties of Rochester. Past Grand Chief Robert G. Ingleson was the last speaker and in an interesting manner told his hearers of the responsibilities of the engineer. At the conclusion of the ceremonies Rochester Council went into executive session and elected Mayor Edgerton an honorary member.

On Thursday morning, in the chamber of the Common Council of the city hall, the annual memorial services were held. Twenty-seven members had died since the last convention. The services were especially impressive because of the passing away of Grand Worthy Chief William H. Armstrong, of New York. John Cope, past grand worthy chief, pronounced the eulogy for the departed and paid a tribute to Mr. Armstrong for the services he had performed in behalf of the organization. Mr. Cope referred with feeling to the widow and three children left by the deceased, and a substantial check raised by the subordinate councils was handed to the widow for the education of the children. At the conclusion of the services the official photograph of the convention was taken.

On Wednesday evening an entertainment was given in the main dining room of the Powers Hotel. The musical and literary numbers were furnished by William Murray, of Jenkins Bros.; Herbert Self, of the Peerless Rubber Manufacturing Co.; B. H. Mustin, of the Lagonda Manufacturing Co., and Jack Armour, of "Power."

On Thursday evening special cars were boarded for a trip to Ontario Beach.

On Friday night a banquet was given at the Powers Hotel. There was good music, and the toastmaster, R. G. Davis, introduced several of the brothers, who made short addresses and told interesting stories. During a pause in the festivities Mrs. Robert G. Ingleson presented a silk American flag to the local council, a gift from the ladies.

The newly elected grand officers are: Charles F. Siegrist, Cleveland, chief; Nathan Burdick, Chicago, assistant chief; Herbert E. Terry, Toronto, secretary; Frank M. Townsend, Grand Rapids, treasurer; Samuel J. Hunt, St. Louis, warden; Frank Conroyd, Chicago, guard; P. H. Early, Milwaukee, chaplain. The trustees are: John Moore, Buffalo; Andrew Benner, Columbus, and William G. Warfield, Newark, N. J. Past Worthy Chief Orrin N. Pomeroy was the installing officer.

Pittsburgh, Penn., was selected as the city in which the next convention was to be held, in August, 1916.

The list of exhibitors follows:

Anchor Packing Co.
Anderson Co., V. D.
Boig & Hill
Crandall Packing Co.
Davidson Co., M. T.
Detroit Stoker Co.
Garlock Packing Co.
Haverstick & Co.
Howe & Bassett Co.
Home Rubber Co.
International Acheson Graphite Co.
Jenkins Bros.
Johns-Manville Co., H. W.
Keystone Lubricating Co.
Lunkenheimer Co.
McDonough Automatic Regulator Co.
McLeod & Henry Co.
Otis Elevator Co.
Peerless Rubber Manufacturing Co.
Powell Co., William
"Power"
Sloan & Co., Samuel
Squires Co., C. E.
Sterling Lubricator Co.
Summerhays & Sons, William
Taylor Instrument Co.
Vacuum Oil Co.
Wheeler-Green Co.

UNIVERSAL CRAFTSMEN COUNCIL OF ENGINEERS AT ROCHESTER CONVENTION

NEW PUBLICATIONS

CATALOG OF TECHNICAL PERIODICALS. Published by the Library Board of the United Engineering Society, New York. Cloth, 126 pages, 8x10½ in. Compiled and edited by Alice Jane Gates, Assistant Librarian, Library of the Engineering Society. Price, $3.

This catalogue should prove of great value to any student of applied science residing in the neighborhood of New York City. It contains a complete list of all the technical periodicals and transactions owned by the following: New York Public Library, Columbia University Library, Library of the American Society of Civil Engineers, Library of the Chemists' Club, Library of the Stevens Institute of Technology, Public Library of Plainfield, N. J., and the Library of the Engineering Societies. The book shows the changes of title, consolidations, cessation of publication, changes in series and completeness or incompleteness of volumes of the serials listed.

ORGANIZATION OF WORK SHOPS AND FACTORIES. By Robert Grimshaw. Lecturer New York University and Pratt Institute. Published by the author, at 1330 St. Nicholas Ave., New York City. Paper, 95 pages; 3½x5½ in. Price, 50c.

To give in a one-hundred-page pamphlet any great knowledge of such a subject would be exceedingly difficult. What Doctor Grimshaw has done is to roughly outline the various functions of a factory organization. The book is really a loosely grouped set of synopses of manufacturing methods and systems for handling and paying labor, and also notices briefly accounting, office and selling methods.

BUSINESS ITEMS

The Joseph Dixon Crucible Co., Jersey City, N. J., is mailing to operators of electric power machinery, and anyone interested in commutation, a new booklet on graphite brushes. "Dixon's Graphite Brushes" is the title and copies are sent for the asking.

The Reeves-Cubberley Engine Company, Trenton, N. J., recently sold two vertical cross compound engines for driving centrifugal pumps for the East Orange Water Works and also booked an order for a 10x10 vertical single cylinder engine for the Henry R. Worthington Company (Chicago office).

The Circuit Court of Cook County, Ill., has recently granted a perpetual injunction to the original Western Kieley Steam Specialty Co., 116 West Illinois St., Chicago, enjoining the Kieley Specialty Co., James McAlear and others from using the name "Kieley" and the word "Specialty" in any combination in any manner whatsoever.

The Whitlock Coil Pipe Company, Hartford, Conn., has recently made installations of the American Standard Copper Coil Feed Water Heaters as follows: Manning Shingle Co., Spokane, Wash., 50 hp.; Shenandoah Cotton Co., Utica, N. Y., 600 hp. and 1320 hp.; Clinchfield Coal Corp., Toms Creek, Va., 200 hp.; Livingston Worsted Co., Washington, R. I., 600 hp.; Oakdale Cotton Mills, Jamestown, N. C., 400 hp., Dunham Hosiery Co., Naugatuck, Conn., 250 hp.; Smith & Cooley Stafford Springs, Conn., Berryman Feed Water Heater.

The Diamond Power Specialty Co., Detroit, Mich., has published three pieces of educational literature which it sends out on request. One piece, entitled "A Consulting Engineer Asks A Question" shows the improvements that have been made in the Diamond soot blower system for hollow staybolt boilers. Pamphlet number two is a treatise on the advantages of clean tubes in fire tube boilers and shows how the Diamond Front End Soot Blower fills the need for a blower of this type. The third circular shows the Diamond Soot Blower for water tube boilers.